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An Evaluation of Steelhead Enhancement in the Ward Creek Drainage, Ketchikan, Alaska, 1991-1994

by

Glenn M. Freeman

December 1995

Alaska Department of Fish and Game

Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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ABSTRACT

Concerns for the efficacy of steelhead *Oncorhynchus mykiss* enhancement in Ward Creek prompted a study to evaluate this work. The goals of this study were to: examine the rate at which hatchery fish residualize; estimate the number of wild and hatchery fish returning to the system; evaluate their contribution to the freshwater fishery; and, estimate the cost of returning enhanced steelhead as well as the cost of each of these fish harvested.

In May 1991, 12,047 age-1.0 steelhead (mean weight 46 g and mean length 160 mm), each bearing an adipose finclip, were planted in Ward Creek. Of these, an estimated 1,318 or failed to smolt and were still present in the system in August 1991. These fish were significantly larger than wild juvenile steelhead in the system.

In spring 1993 and 1994, all adult steelhead entering Ward Creek were captured at an aluminum bipod and picket weir where they were counted, sampled, and marked. Adult steelhead leaving Ward Creek in 1993 and 1994 were inspected for marks and their abundance was estimated using a Peterson model. In 1993 an estimated 337 steelhead entered Ward Creek, and 33 of those were from the 1991 smolt release. The 1994 steelhead return to Ward Creek was estimated at 412 of which 92 were planted in 1991, for a combined two-year return of 125.

In 1993 and 1994, creel surveys were conducted to estimate the number of steelhead caught and harvested and to estimate the effort expended by anglers fishing for steelhead. Steelhead anglers fished 603 hours in 1993 to harvest 13 hatchery steelhead of which 5 were from the 1991 release. In 1994, anglers expended 1,243 hours to harvest 14 hatchery steelhead of which 12 were from the 1991 release.

The 1991 plant generated an estimated total return of 125 steelhead, or 17% of the 1993 and 1994 return total. Seventeen of these fish were harvested. Based on an estimated cost of $9,736 to rear and stock steelhead in Ward Creek in 1991, each returning fish from this release cost $77.89 and each fish harvested from the Ward Creek system cost $573.

Key words: Steelhead, *Oncorhynchus mykiss*, Ward Creek, Ketchikan, Southeast Alaska, enhancement, hatchery, wild, smolt, mark-recapture experiment, creel survey, residuals, immigrant, kelt, emigration, sport fishery, overharvest, competition.

INTRODUCTION

Introductions of hatchery steelhead *Oncorhynchus mykiss* in the Ward Creek system (Figure 1), which began in 1981, were motivated by the general desire of the Department of Fish and Game, Division of Sport Fish to create or enhance steelhead fisheries in the region (Jones 1977) and to mitigate losses of steelhead caused by a chlorine spill by the Ketchikan Pulp Company in 1978 (Siedelman *unpublished* 1979). In 1979, an out of court settlement between the State of Alaska and Louisiana Pacific Corporation-Ketchikan provided $48,000 to purchase tanks for the Deer Mountain Fish Hatchery (Siedelman *unpublished* 1980) to rear steelhead for release in Ward Creek. Consequently, steelhead brood was taken from Ketchikan Creek, fish were reared at this facility, and planted into Ward Creek from 1981-1985 (Table 1). Subsequently steelhead enhancement was continued to provide for harvest while reducing pressure on wild stocks. To improve growth rates of juvenile fish, the project was transferred to the Klawock Lake Hatchery (Prince of Wales Island, 100 km west of Ketchikan) in 1984. Thereafter one-year-old steelhead smolt propagated from gametes collected in the Klawock River and reared at the Klawock hatchery, were released annually in Ward Creek from 1985 to 1993. Fish were expected to smolt immediately after stocking, thereby minimizing competition with wild steelhead and other species rearing in Ward Creek. Drawbacks of this program were: the desired steelhead size-at-release averages of 45g and 170-180 mm FL (Bentz 1991; Van Hulle 1985), even with superior growth rates at Klawock Hatchery, were achieved in only about half of the steelhead releases; unknown

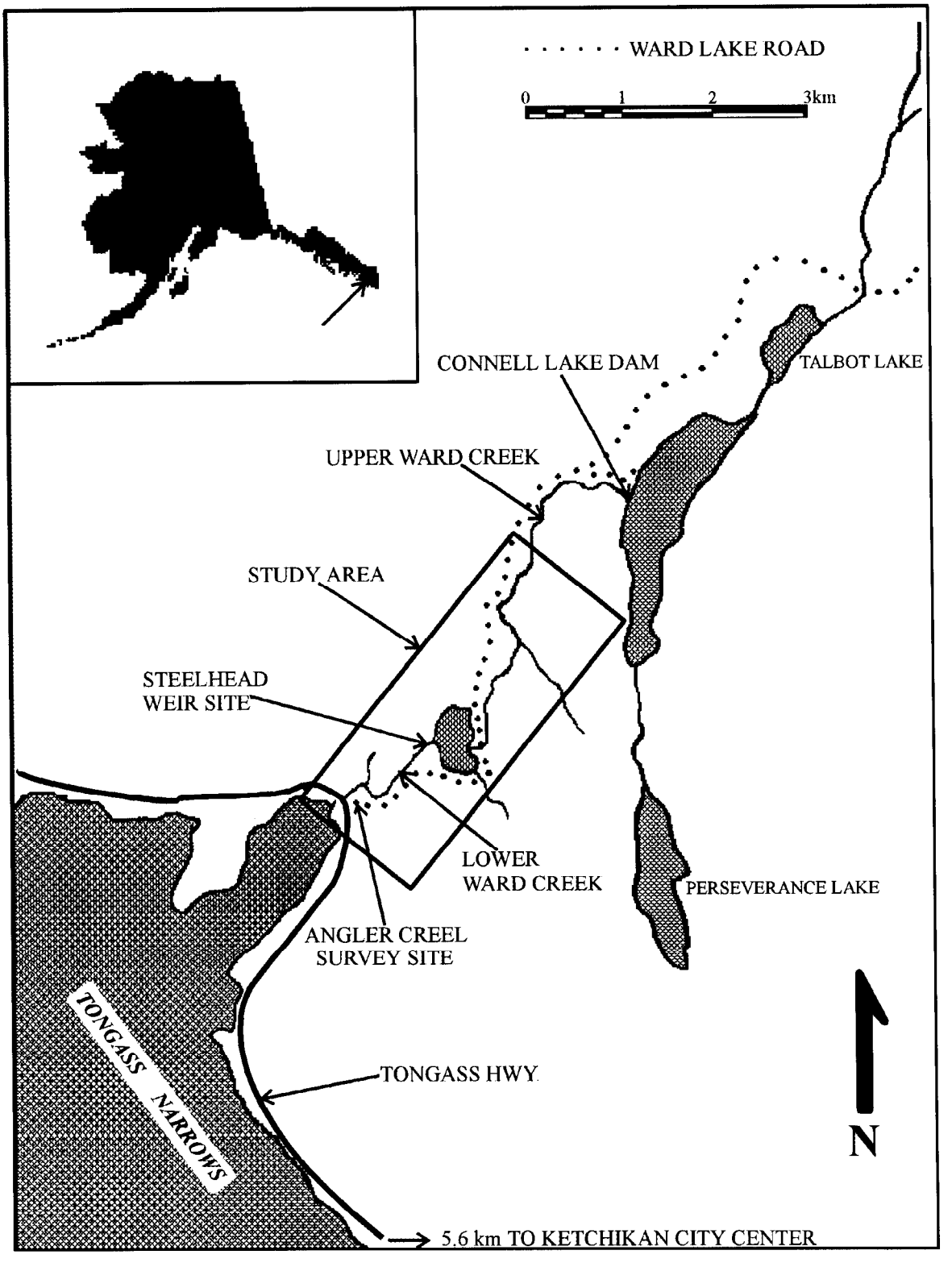

Figure 1.-Ward Creek steelhead study area, Revillagigedo Island, Alaska.

Table 1.-History of steelhead enhancement by the Alaska Department of Fish and Game at Ward Creek.

Stock Origin	Brood Year	Date Released	Age	Number Released	Mean Length (mm)	Mean Weight (g)
Klawock River	1992	5/26/93	1	11,406		46.3
Klawock River	1991	6/92	1	9,632		41.0
Klawock River	1990	5/28/91	1	12,047	160[a]	46.0[a]
Klawock River	1988	5/15/89	1	38,667		14.9
Klawock River	1987	5/15/88	1	19,648		45.0
Klawock River	1986	5/19/87	1	28,687		39.7
Klawock River	1985	5/25/86	1	28,325		30.5
Klawock River	1984	6/7/85	1	21,918		25.0
Ketchikan Creek	1981	12/82	1^+	4,916	174	52.1
Ketchikan Creek	1981	12/82	1^+	2,952	139	27.6
Ketchikan Creek	1980	5/25/82	2	1,479	172	62.5
Ketchikan Creek	1978	6/80	2	545	164	42.6
Ketchikan Creek	1978	6/80	2	1,178	144	30.3
Ketchikan Creek	1978	6/81	3	2,816	230	146.4

[a] Mean steelhead length and weight from measurements taken 12 days prior to release at Ward Creek.

numbers of released fish residualized in Ward Creek; and, because Klawock River supports both fall-run and spring-run steelhead, unknown proportions of each were included in annual egg-takes and fish planted in Ward Creek.

A significant and popular steelhead fishery in Ward Creek was first recorded by the Statewide Harvest Survey in 1981 (Figure 2). Harvests rapidly increased and by the mid-1980s often exceeded 400 fish per year. In general, the trend in steelhead harvests was reminiscent of harvests throughout the Ketchikan area, though there is anecdotal evidence that extraordinary angling effort may have been focused on Ward Creek because of its steelhead enhancement program.

Prompted by increased angling pressure which was attributable in part to steelhead enhancement at Ward Creek, the Division of Sport Fish conducted creel surveys to estimate catch and harvest of wild and hatchery steelhead in the fishery. The studies found that 9% of the steelhead caught and kept in 1988 and 20% of the steelhead harvested in 1989 were from smolt directly released from the hatchery (Hubartt 1989; Hubartt 1990), and the remainder were composed of fish produced within the system. Because these findings showed that direct enhancement did not make large contributions to the Ward Creek sport fishery, the Division proposed discontinuing the program in 1990. However, local anglers protested the proposal, citing disagreement with the creel survey. To obtain conclusive evidence of the efficacy of planting steelhead to enhance the Ward Creek steelhead fishery, the Division of Sport Fish conducted a study to estimate the return, fishery contribution, and costs of the enhancement program. This was done by estimating the smolting rate of 1990 brood steelhead released into Ward Lake in 1991 and by estimating the return and harvest of fish from the 1991 release in 1993 and 1994. Specifically, the project had the following objectives:

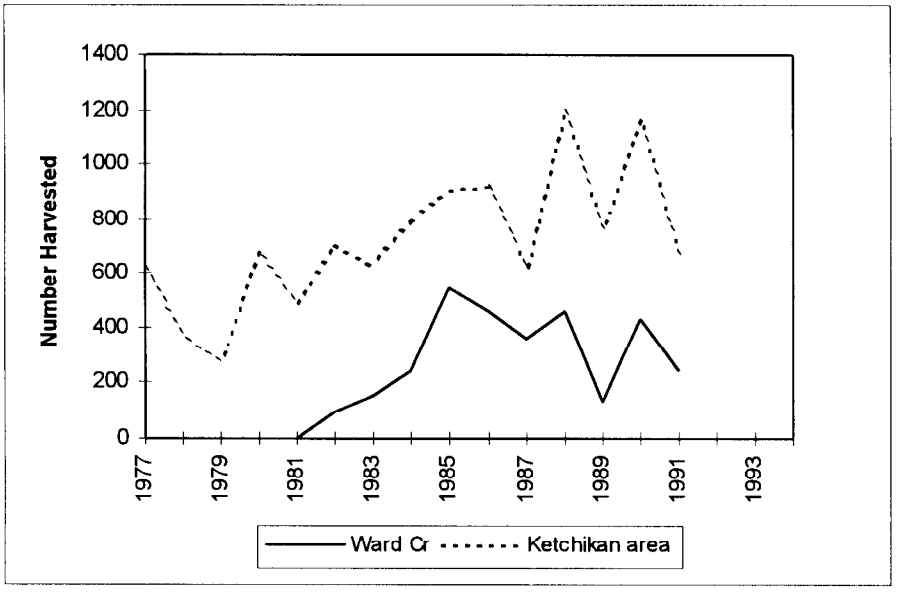

Figure 2.-Freshwater harvest of steelhead at Ward Creek and in the Ketchikan area from Mills (1977-1991). Data for 1992 through 1994 have been omitted because harvest during those years was significantly affected by restrictive regulations.

1. estimate the number of hatchery steelhead planted in Ward Creek in May 1991 which remained in the Ward Creek system in mid July-1991;
2. count the return of hatchery and wild steelhead into the Ward Creek system above the weir during the springs of 1993 and 1994;
3. estimate the return of hatchery steelhead from the 1991 release in Ward Creek above the weir during the springs of 1993 and 1994;
4. estimate the angler effort and harvest of hatchery steelhead from the 1991 release in Ward Creek during the springs of 1993 and 1994; and
5. estimate the age composition and mean length-at-age of immigrating wild steelhead during the springs of 1993 and 1994.

Throughout this report the term "wild" steelhead is used for all fish with adipose fins intact, and may include native fish, progeny from introduced fish, or progeny from (interbred) native and introduced fish. The cumulative positive or negative effects from indirect steelhead enhancement (i.e., interbreeding between earlier generations of hatchery and wild steelhead which resulted in fish with adipose fins intact) were not evaluated.

METHODS

ESTIMATE OF RESIDUALS

Twelve thousand forty-seven (12,047) age-1.0 steelhead (1990 brood) with a mean fork-length of 160 mm and mean weight of 46 g were planted in Ward Creek, 100 m upstream of Ward Lake, on May 28, 1991. After allowing more than seven weeks for the fish to emigrate, a two event mark-recapture experiment for a closed population (Seber

1982) was conducted between July 22 and August 21, 1991 to estimate the number of stocked steelhead remaining in the Ward Creek system (Freeman 1992). The estimated number of residuals subtracted from the number of fish planted produced the number of steelhead in 1991 that smolted.

ABUNDANCE AND AGE OF THE RETURNING STEELHEAD

Studies of steelhead at Klawock River (Freeman and Hoffman 1989), Thorne River (Freeman and Hoffman 1990, 1991), and Karta River (Hoffman, et al. 1990), showed that steelhead return after two or three years at sea. Based on these studies we expected that Ward Creek steelhead would return over the same time period, and that because there are both fall-run and spring-run components in the population, the return from the 1991 release would occur in fall 1992/spring 1993 and fall 1993/spring 1994. A mark-recapture experiment combined with a weir count of returning fish was used to estimate the abundance and proportions of hatchery and wild fish returning during these periods.

An aluminum bipod and picket weir was erected 1.2 km above tidewater, near the outlet of Ward Lake (Figure 1), to count and sample upstream and downstream migrating adult steelhead. All fish passing the weir from March 22-June 6, 1993 and March 12-July 12, 1994 were captured in a trap in the weir, counted, and inspected for a missing adipose fin (all fish planted in 1991 were adipose finclipped); all hatchery fish and wild immigrants were sampled for age, sex and length. Hatchery fish from the 1991 release were distinguished from fish from other releases by age analysis from reading scales. Each upstream migrant was marked by punching a 6 mm diameter hole in the upper caudal fin and each downstream migrant was marked by punching a 6mm diameter hole in lower caudal fin. Additionally, in 1994, a uniquely numbered Floy© tag was applied to immigrating hatchery steelhead. Water temperature (nearest 1°C) and stream water level (nearest mm) were measured adjacent to the weir at about 0800 hours each day.

Immigrating steelhead were captured in an upstream migrant trap, removed with a dip net, and measured to the nearest 5 mm fork length (tip of snout to fork-of-tail). Scales were removed from the fish in order to estimate their age. Date, time of passage through the weir, sample number, adipose fin presence, sex (if discernible), and comments on scars were also recorded. Emigrating steelhead were captured in a separate trap as they left the system. Any hatchery steelhead not marked with a caudal punch was sampled like those passed upstream, then released below the weir. Downstream migrating wild steelhead were checked for caudal punch marks, counted, then released below the weir with minimal handling.

Four scales were collected from each side of every fish sampled. Scales were taken from an area two scale rows above the lateral line on a diagonal line from the posterior end of the dorsal fin to the anterior end of the anal fin. Scale samples were mounted on gum cards, and triacetate impressions of the scales (550 kg/cm^2 pressure at a temperature of 80°C for 6 minutes) were prepared for use in estimating age.

Steelhead scales were aged using methods described by Jones (*unpublished*) and Narver and Withler (1971). Three blind readings of the scales were done, and modal age analysis was used to determine the age of each sample; i.e., the most frequent reading was selected as the age. Age compositions of the hatchery and wild populations were estimated as in (11) and (12) where superscripts denote the population (* indicates hatchery origin) and year is substituted to denote the population(s) of interest. The mean and standard deviations

for the lengths measured were calculated using standard procedures.

In practice, it is false to assume the weir will stop all immigrants, since some arrive prior to weir construction. Thus, the Chapman modified Petersen (mark-recapture) estimator (Seber 1982) was used to estimate (separately) the total immigrations of hatchery and wild steelhead to Ward Creek. Marks were applied to upstream migrants as noted above, and the marked to unmarked ratio of the population above the weir was estimated from the mark status of the downstream (kelt) migrants sampled prior to removal of weir operations. Abundance was estimated:

$$\hat{N} = \frac{(n_1+1)(n_2+1)}{(m_2+1)} - 1 \qquad (1)$$

$$V[\hat{N}] = \frac{(n_1+1)(n_2+1)(n_1-m_2)(n_2-m_2)}{(m_2+1)^2(m_2+2)} \qquad (2)$$

where:

$\hat{N}$ = number of immigrant steelhead in Ward Creek at time of tagging at weir;

n_1 = number of immigrant steelhead marked at weir;

n_2 = number of steelhead kelts examined for marks;

m_2 = number of steelhead kelts examined that were marked at the weir.

The estimate is germane to the immigrants from the fall-spring population above the weir that were alive when tagging began. Since a presumably small number of immigrants (fall and early spring fish) died from natural causes and fishing mortality *prior* to installation of the weir, they are not included in the estimate (which is thus biased downward by the magnitude of mortalities occurring prior to weir operations). In a creel survey conducted at Ward Creek from fall 1988 to spring 1989, Hubartt (1990) estimated that 9% of the total harvest of steelhead occurred prior to April 1989. Thus, a small number of fish were assumed to be harvested prior to weir installation in March 1993 or 1994. Some steelhead which passed the weir died of natural causes and fishing mortality before emigrating as kelts, but both marked and unmarked fish are assumed to be equally susceptible to death after passing the weir, so the estimate of the number alive at the time of tagging is unbiased.

Tag loss was not a problem because hatchery fish were double-marked at the weir and because mixing of the marked and unmarked fish above the weir was indicated from the uniform distribution of tags (over time) among emigrant kelts (in 1993) or the nearly complete count of emigrant kelts (in 1994). A small number of repeat spawners from 1991 releases were expected to return in 1994. Having spawned initially in 1993, they were not included in the 1994 estimate.

Abundance of hatchery steelhead from the 1991 release ($\hat{N}^{*1991}$) was estimated:

$$\hat{N}^{*1991} = p^{*1991}\hat{N}^{*} \qquad (3)$$

where $\hat{N}^{*}$ is the abundance of hatchery fish, and the proportion of hatchery fish that belong to the 1991 release (p^{*1991}) was estimated in (11). The variance was estimated:

$$V[\hat{N}^{*1991}] = V[\hat{p}^{*1991}](\hat{N}^{*})^2 + V[\hat{N}^{*}](\hat{p}^{*1991})^2 - V[\hat{p}^{*1991}]V[\hat{N}^{*}] \qquad (4)$$

ANGLER EFFORT, CATCH, AND HARVEST SURVEY

A stratified two-stage direct expansion survey (Cochran 1977) of anglers exiting the Ward Creek drainage was used to estimate angler effort, catch, and harvest of steelhead in the Ward Creek system between March 22 and May 30, 1993, and between March 14 and May 22, 1994. Throughout this report,

"catch" refers to the sum of fish harvested and released. Ten unique, weekly strata were maintained each year. The design utilized days of the week as primary sampling units and anglers within days as secondary sampling units. The creel survey was conducted five days per week (randomly selected), except during the first survey week, when anglers were surveyed on three days, and the second survey week of 1993, when anglers were surveyed on four days.

Anglers were counted as they left the drainage during a sampled day, and nearly all were interviewed by a technician stationed at a vehicle pullout (Figure 1) on the lower Ward Creek Road. Signs requesting anglers to stop at the designated reporting station and report their catch and fishing effort were posted near popular fishing areas, and both before and at the reporting station. During each interview, anglers were asked how many hours they fished for steelhead (to the nearest 15 min), how many steelhead they kept (adipose clipped or unclipped fish separately), and how many fish they released (adipose clipped and unclipped fish, if known). All anglers, including those who were not interviewed were counted.

I assumed that an insignificant number of anglers exited the area outside of survey hours (0600 hours to civil twilight) and that an insignificant proportion of anglers avoided the technician or dishonestly reported their effort and catch.

Harvests (and catches) of steelhead which originated from the spring 1991 smolt release were calculated by multiplying the estimated number of hatchery (clipped) fish harvested (or caught) by the proportion of adipose-clipped fish in creel and weir samples that were from the 1991 release. The estimated proportion was based on ages determined from scales that were successfully aged.

An unknown but presumably small number of fall-run fish were harvested prior to onset of weir or creel operations in March of 1993 and 1994. This is supported by patterns in the fall 1988/spring 1989 fishery at Ward Creek, when an estimated 33% of the hatchery steelhead (and 9% of all steelhead) were harvested and 14% of the steelhead effort occurred prior to mid-March (Hubartt 1990).

Overall harvests (H_h) of fish with adipose fin clips, fish without adipose fin clips, and fish without regard to adipose clip status in each stratum h were estimated (separately):

$$\hat{H}_h = D_h \bar{H}_h \quad (5)$$

$$\bar{H}_h = \frac{\sum_{i=1}^{d_h} \hat{H}_{hi}}{d_h} \quad (6)$$

$$\hat{H}_{hi} = M_{hi} \bar{h}_{hi} \quad (7)$$

$$\bar{h}_{hi} = \frac{\sum_{j=1}^{m_{hi}} h_{hij}}{m_{hi}} \quad (8)$$

where h_{hij} is the harvest by angler j in sampling day i stratum h, m_{hi} is the number of anglers interviewed in day i, M_{hi} is the number of anglers completing trips in day I, d_h is the number of days sampled in stratum h, and D_h is the number of days in stratum h. The variance of the harvest by stratum is:

$$V[\hat{H}_h] = (1-f_{1h})\, D_h^2 \frac{\sum_{i=1}^{d_h} (\hat{H}_{hi} - \bar{H}_h)^2}{d_h\,(d_h-1)} + \quad (9$$

$$D_h \sum_{i=1}^{d_h} M_{hi}^2\, (1-f_{2hi}) \frac{\sum_{j=1}^{m_{hi}} (h_{hij} - \bar{h}_{hi})^2}{d_h\, m_{hi}\,(m_{hi}-1)}$$

where f_{1h} = the sampling fraction for days, and f_{2hi} = sampling fraction for anglers.

Harvests for the season were estimated by the sums across strata ΣH_h and $\Sigma V[H_h]$.

Angler effort (E) and catch (C) were estimated by the same formulae, substituting E and C for H.

Harvests of hatchery-reared steelhead originating from the 1991 release ($\hat{H}_h^{*1991}$) into Ward Lake were estimated:

$$\hat{H}_h^{*1991} = \hat{p}^{*1991} \hat{H}_h^{*} \quad (10)$$

where $\hat{H}_h^{*}$ is the harvest of hatchery fish, and the proportion of hatchery fish that belong to the 1991 release (p^{*1991}) was estimated :

$$\hat{p}^{*1991} = \frac{n^{*1991}}{n^{*}} \quad (11)$$

$$V[\hat{p}^{*1991}] = \left[1-\frac{n^{*}}{N^{*}}\right]\frac{\hat{p}^{*1991}(1-\hat{p}^{*1991})}{n^{*}-1} \quad (12)$$

where n^{*} is the number of aged scales from hatchery fish, n^{*1991} is the number of aged scales from hatchery fish from the 1991 release in weir and creel survey samples combined, and N^{*} is the estimated total number of hatchery fish in the return. The variance of the harvest was estimated:

$$V[\hat{H}_h^{*1991}] = V[\hat{p}^{*1991}](\hat{H}_h^{*})^2 + \quad (13)$$

$$V[\hat{H}_h^{*}](\hat{p}^{*1991})^2 - V[\hat{p}^{*1991}]V[\hat{H}_h^{*}]$$

after the formula from Goodman (1960) for the product of two independent random variables.

EVALUATION

The combined costs of staffing, egg take, incubation, and rearing associated with the 1991 release of steelhead in Ward Lake were obtained from the Commercial Fisheries Management and Development Division of the Alaska Department of Fish and Game. Cost per returning steelhead was calculated using the methods described in Bentz, et al. (1991) and compared to cost data from other hatchery programs.

RESULTS

ESTIMATE OF RESIDUALS

An estimated 1,318 (SE = 114), or 11% of the juvenile hatchery steelhead planted in 1991 remained in the Ward Creek drainage through July 1991 (Freeman 1992). Therefore, of the 12,047 age-1.0 steelhead planted, 10,729 actually smolted. Roughly half of the residuals sampled were captured in Ward Lake, and the other half in stream habitats (mostly Ward Creek above and below Ward Lake). Most wild steelhead occurred in stream habitats: 79% of the wild steelhead $\geq$ 110 mm FL were found in streams and 97% of the wild steelhead < 110 mm were in streams.

ABUNDANCE AND AGE OF RETURNING STEELHEAD

1993 Return

The weir on Ward Creek operated successfully between March 22 and June 6. Water temperatures ranged from 4°C on April 2 to 17°C on June 5 (Appendix A1) and water levels ranged between 29 cm (June 5) and 135 cm (May 1). Between March 22 and June 6, 30 hatchery steelhead and 79 wild steelhead were counted upstream through the weir (Table 2; Appendix A1); the peak immigration occurred from April 26 to May 2 (Figure 3). Scale samples were collected from 28 of the 30 hatchery steelhead passed upstream, and 27 samples had readable scales. Analysis of these scales indicated that 12 of the 27 (44%) were hatchery steelhead released at Ward Lake in 1991 (Appendix A2). The remaining 56% were released in or prior to 1989 (Appendix A2).

Of 76 steelhead counted downstream, 33 were hatchery and 43 were wild fish (Appendix A1). The peak emigration of hatchery

Table 2.-Number and origin of unique steelhead counted at the Ward Creek weir, 1993 and 1994.

	Immigrants					Emigrants[b]				
		Hatchery					Hatchery			
	Wild	1991 Release	Other Releases	Unknown Release[a]	Total	Wild	1991 Release	Other Releases	Unknown Release[a]	Total
1993	79	12	15	3	109	30	6	14	2	52
1994	220	37	9	7	273	48	29	4	3	84

[a] Steelhead scales were unreadable or not collected.

[b] Only the number of unique (unmarked) fish which immigrated to Ward Creek prior to weir installation are shown.

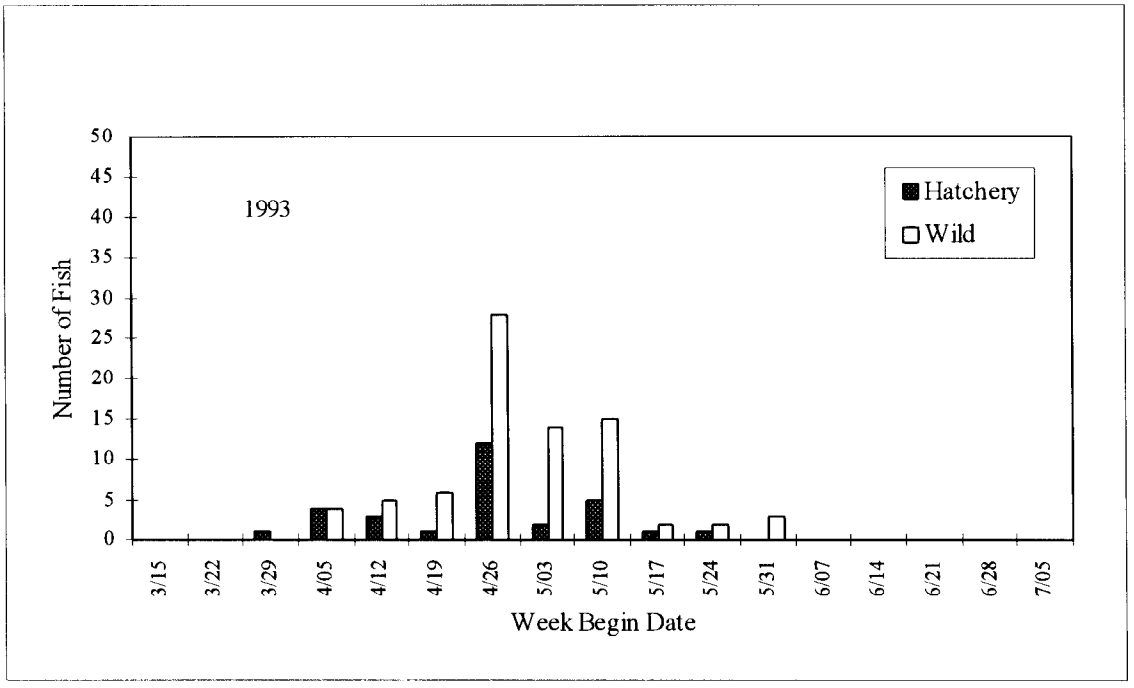

Figure 3.-Upstream migration timing of adult steelhead at the Ward Creek weir, spring 1993.

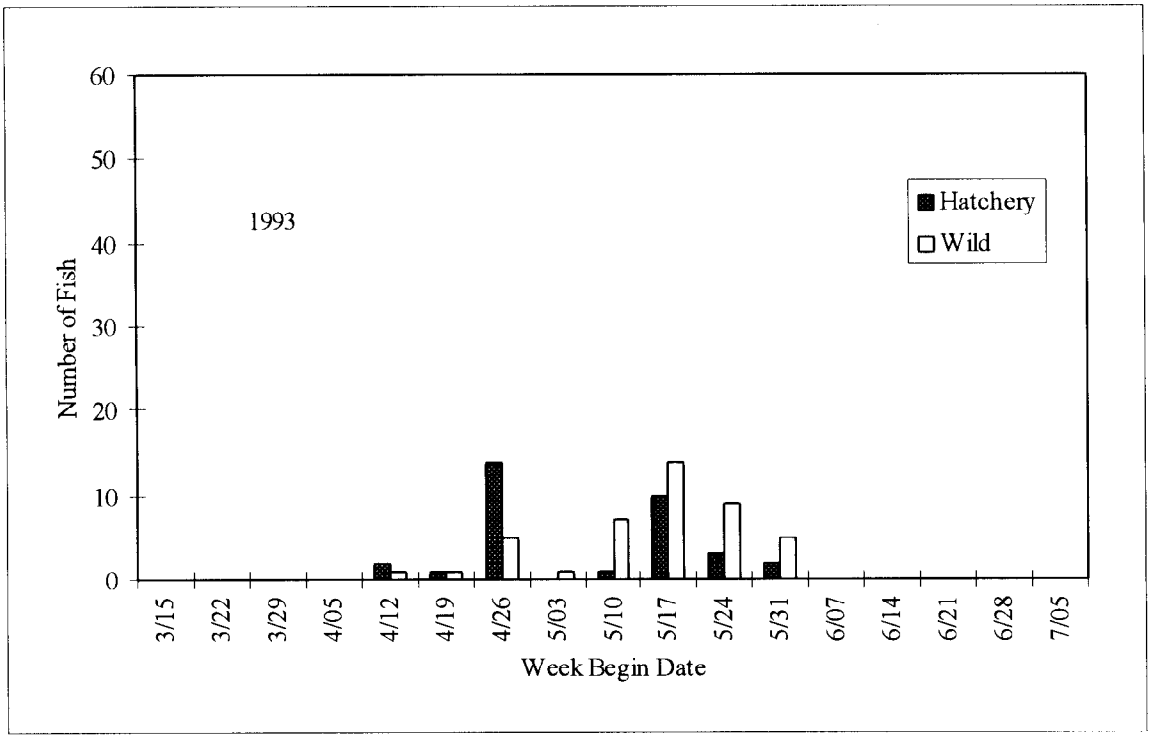

Figure 4.-Downstream migration timing of adult steelhead at the Ward Creek weir, spring 1993.

steelhead occurred from April 26 to May 2, and the peak emigration of wild fish occurred from May 17 to May 23 (Figure 4). Of the 33 emigrating hatchery steelhead, 22 had not been marked with a caudal punch mark, indicating that these fish were present in Ward Creek prior to installation of the weir. Of the 22, scales were collected and readable for 20 fish; 6 of the 20 were determined to be hatchery steelhead released at Ward Creek in 1991 (Appendix A3). The remaining 14 scales aged were from fish released in or prior to 1989. Thirty of the 43 emigrating wild steelhead were unmarked from the upstream sampling. An estimated 20 steelhead kelts remained just upstream of the weir when it was pulled on June 6. Most fish which remained upstream of the weir when pulled were likely wild because wild fish comprised more than two-thirds of the emigrants after mid-May (Appendix A3). Combining upstream (12 of 27) and downstream (6 of 20) migrants, a total of 18 of 47, or 38% of the hatchery steelhead aged from the 1993 weir samples were from the 1991 release.

A mark-recapture experiment conducted by marking immigrants in the spring and inspecting fish as they emigrated determined the total return to be 337 fish (SE = 51)[1]. Of these, an estimated 87 (SE=15) were hatchery fish from various releases that had returned to Ward Creek in the fall 1992 or spring 1993 and had survived natural and fishing mortality to the time weir operations began. An estimated 33 (SE=7) of these 87 fish were from the 1991 release in Ward Creek. An estimated 250 (SE=49) were wild steelhead which returned to Ward Creek from fall 1992 to spring 1993 and survived natural and fishing mortality to the time weir operations began.

[1] Sampling parameters were: 1993 hatchery fish (n1=30, n2=33, m2=11); 1993 wild fish (n1=79, n2=43, m2=13).

Of 54 hatchery steelhead aged from weir (upstream and downstream migrants) and angler creel samples in 1993, 21 (39%) were released at Ward Creek in 1991 (Appendix A2; Appendix A3). All 21 fish were age-1.2, with a mean length of 598 mm (Table 3). Fifty-six percent (30) of the 54 hatchery steelhead that were aged returned to spawn in 1993 for the first time; 44% were repeat spawners from earlier releases. The mean length was 610 mm for first-time spawners, 759 mm for repeat spawners, and 676 mm for all aged hatchery fish (Table 3). The breakdown of hatchery fish aged, excluding fish which had unreadable or regenerated scales, is shown in Figure 5.

Of 66 wild steelhead assigned ages in 1993, 82% were first-time spawners and 18% were repeat spawners (Figure 6). The mean length was 713 mm for first-time spawners, 781 mm for repeat spawners, and 724 mm for all wild fish aged (Table 3). A length frequency distribution of hatchery and wild steelhead is charted in Figure 7.

1994 Return

In 1994, the weir was operated from March 12-July 12. Water temperatures ranged from 4°C during late March to 17°C on June 26, and stream water levels ranged from 29.0 cm on June 5 to 178 cm on June 2 (Appendix A4). Between March 19 and July 10, 53 hatchery steelhead and 220 wild steelhead were counted upstream through the weir (Table 2; Appendix A4). The peak immigration of hatchery fish occurred during the week of April 11 to April 17, and the peak immigration of wild fish occurred from April 25 to May 1 (Figure 8). Scale samples were collected from 50 of the 53 hatchery steelhead passed upstream, and 46 had readable scales. Scale analysis indicated that 37 of the 46 fish aged originated from the 1991 release (Appendix A5).

Scale analysis also revealed that 2 of the 37 fish identified as being from the 1991 release were repeat spawners which first spawned in 1993, and 5 others had remained in Ward Creek until spring 1992, when they smolted.

Of 246 steelhead counted downstream, 69 were hatchery fish and 177 were wild (Appendix A4). Of the emigrating hatchery steelhead kelts, 36 were not marked with a caudal punch and 33 of these yielded readable scales; 29 of the 33 aged fish were determined to have originated from the 1991 release (Appendix A6). Three hatchery fish aged to the 1991 release were repeat spawners which first spawned in 1993, and one fish had residualized in Ward Creek in 1991-1992. Forty-eight (27%) of the 177 emigrating wild steelhead kelts were unmarked and 129 (73%) were marked. Peak emigration for hatchery and wild steelhead alike occurred during the week of May 23 to 29 (Figure 9). Twelve steelhead kelts were observed just upstream of the weir when it was pulled on July 10. Combining upstream (37 of 46) and downstream (29 of 33) migrants, a total of 66 of 79, or 84% of the hatchery steelhead aged from the 1994 weir samples were from the 1991 release.

In a mark-recapture experiment done by marking immigrant steelhead and inspecting emigrants for marks, the total return was estimated at 412 (SE=12)[2] steelhead. An estimated 110 (SE=8) were hatchery steelhead from various releases that had returned to Ward Creek during fall 1993 and spring 1994 and survived natural and fishing mortality to the time weir operations began. Of these hatchery steelhead, 92 (SE=7) were from the 1991 release in Ward Creek.

[2] Sampling parameters were: 1994 hatchery fish (n1=53, n2=69, m2=34); 1994 wild fish (n1=220, n2=177, m2=129).

Table 3.-Mean length at age of unique hatchery and wild steelhead sampled at Ward Creek, 1993.

	Hatchery				Wild			
Age class	Length[a]	n	SE	Percent	Length[a]	n	SE	Percent
First-time spawners								
1.2	598	21	7	39				
2.2					630	2	5	3
2.3	550	2	0	4				
3.2	625	1		2	632	9	22	13
3.3					758	18	13	26
4.2					621	5	23	7
4.3					754	20	12	29
R.2[b]					636	4	7	6
R.3[b]	670	6	43	11				
Subtotal	610	30	11	56	713	58	11	84
Repeat spawners								
1.3S1	810	1		2				
2.2S1	771	5	25	9	790	1		1
2.2S1S1	830	1		2				
2.3S1	788	2	18	4				
3.2S1	797	3	33	5	750	4	11	6
3.3S1					793	2	32	3
4.2S1					780	3	12	4
R.2S1[b]	726	9	13	16				
R.2S1S1[b]	730	1		2	820	1		1
R.3S1[b]	744	2	99	4	780	1		1
Subtotal	759	24	12	44	781	12	10	16
Unreadable		2				3		
TOTAL[c]	676	56	13	100	724	73	9	100

[a] Mean of fork lengths measured to the nearest 5 mm.

[b] R = scales regenerated; freshwater age undetermined.

[c] Length data for fish with unreadable scales is not included.

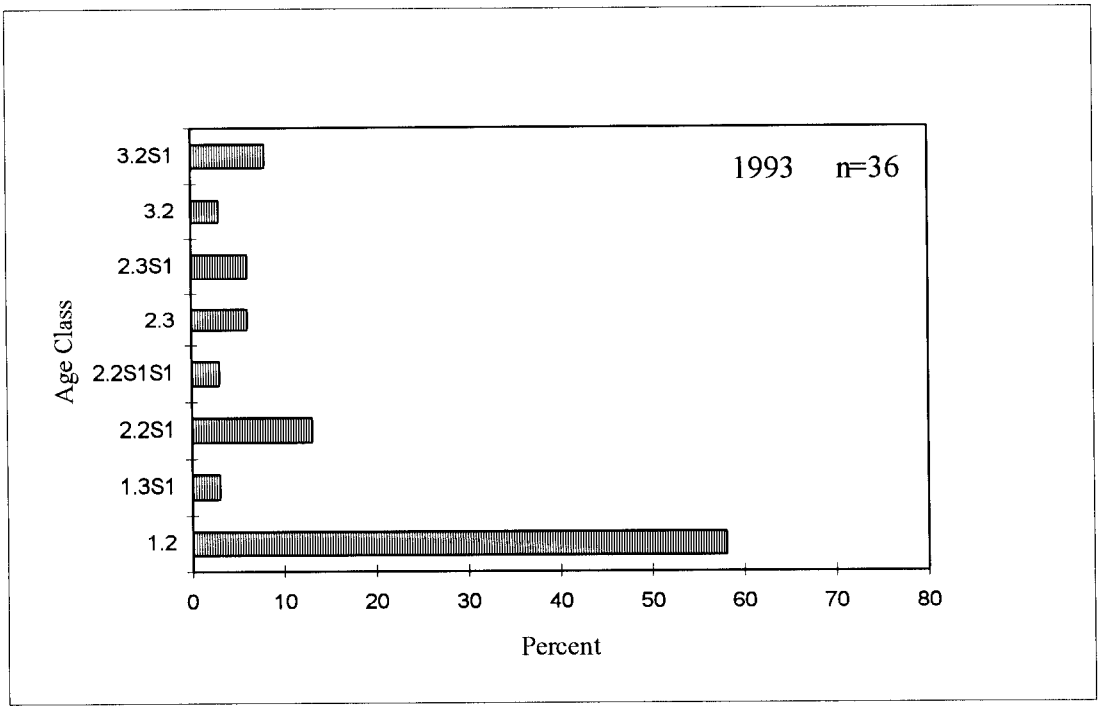

Figure 5.-Age classes of hatchery steelhead sampled at Ward Creek, spring 1993.

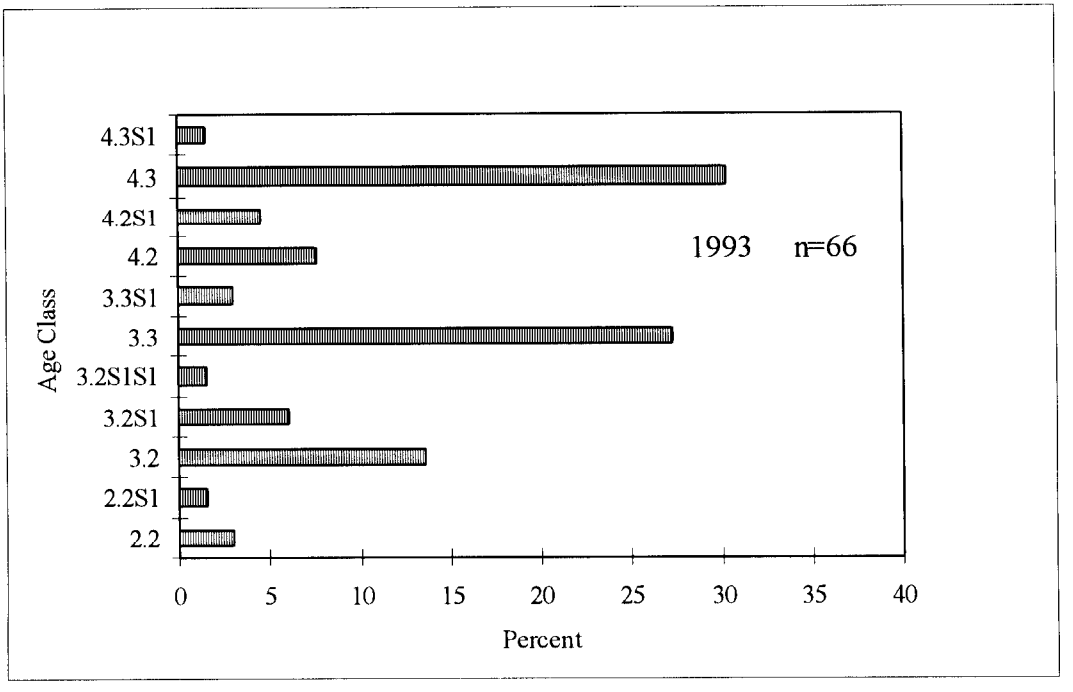

Figure 6.-Age classes of wild steelhead sampled at Ward Creek, spring 1993.

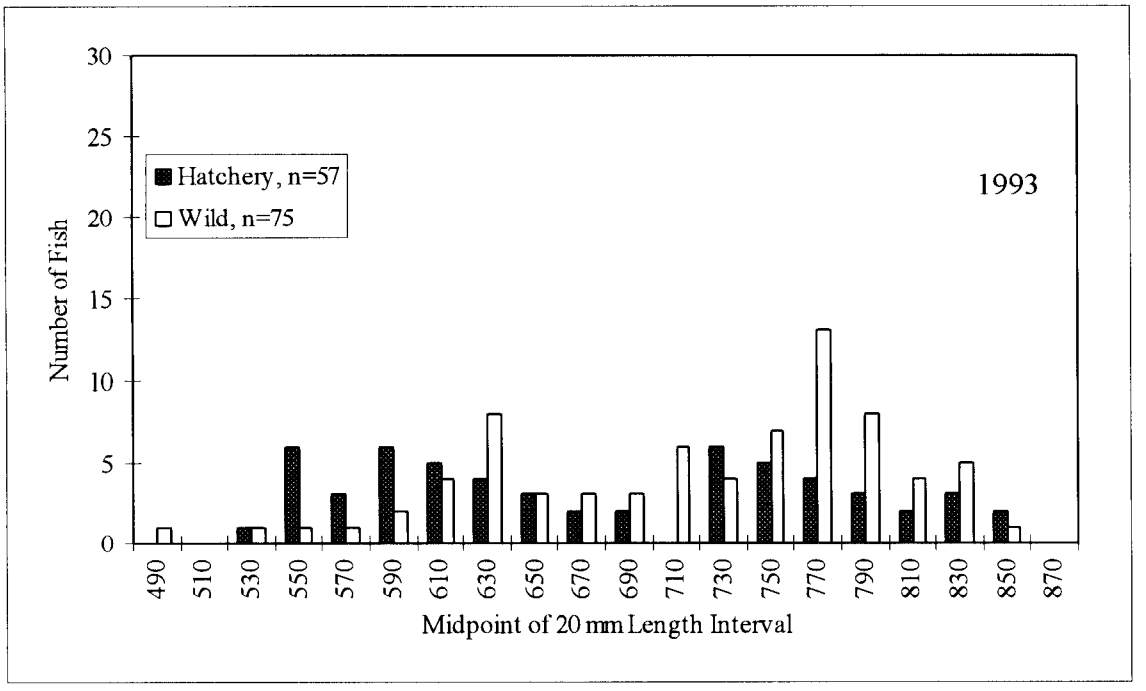

Figure 7.-Length frequency distribution of unique hatchery and wild steelhead sampled at Ward Creek, spring 1993.

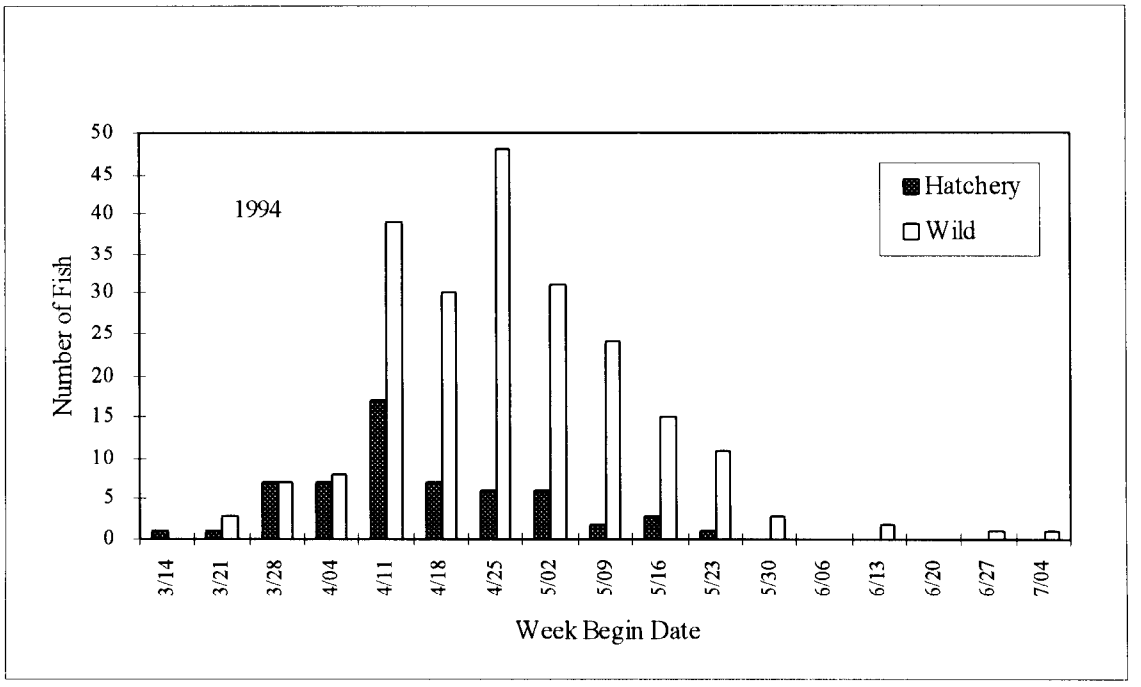

Figure 8.-Upstream migration timing of adult steelhead at the Ward Creek weir, spring 1994.

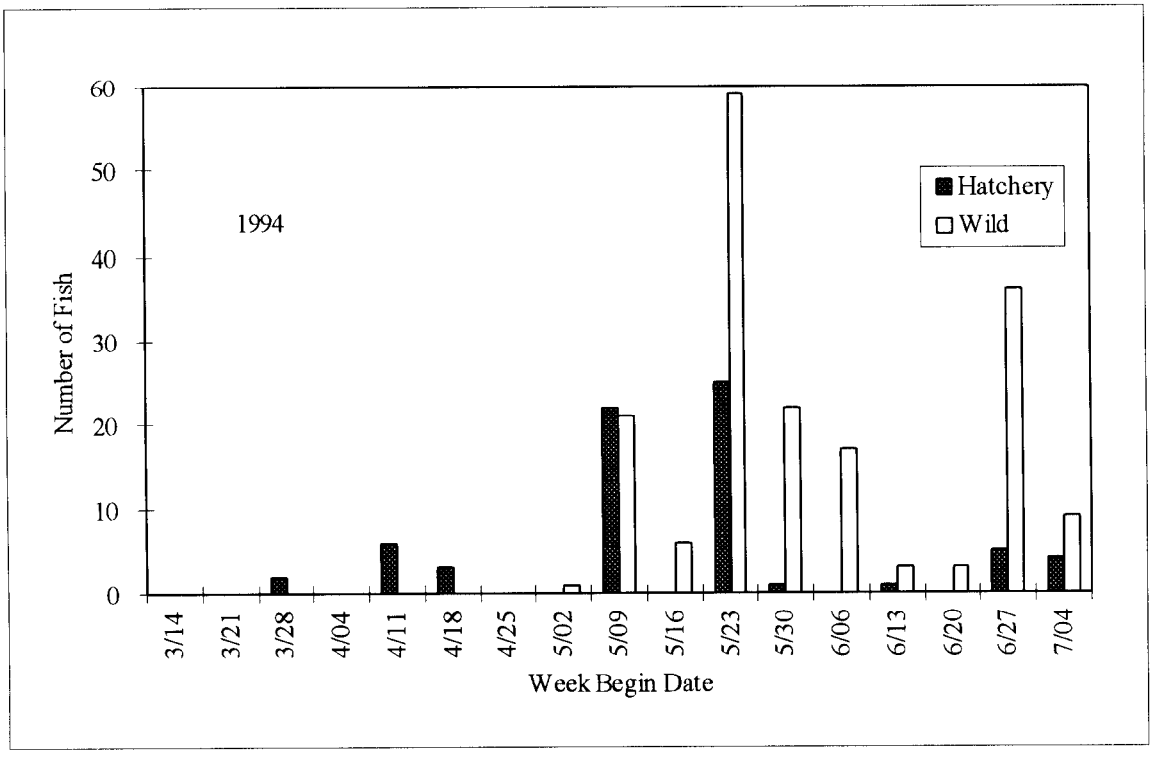

Figure 9.-Downstream migration timing of adult steelhead at the Ward Creek weir, spring 1994.

An estimated 302 (SE=9) wild steelhead also returned to Ward Creek from fall 1993 to spring 1994 and survived natural and fishing mortality to the time weir operations began.

Seventy-one of 86, or 83% of the hatchery steelhead aged in 1994 were determined to be from the 1991 release at Ward Creek. Of the 1991 releases, 85% were age-1.3, 8% were age-2.2, and 7% were on their second spawning run as age-1.2S1 fish (Table 4). Twenty-six of the 71 were males and 45 were females; 70 of the 86 hatchery steelhead returned to spawn in 1994 for the first time. The mean length for first-time spawners was 705 mm, of repeat spawners 723 mm, and 708 mm for all hatchery fish aged (Table 4). The breakdown of hatchery fish aged, excluding fish which had unreadable or regenerated scales is shown in Figure 10.

Of 195 wild steelhead aged in 1994, 94% were first-time spawners and 6% were repeat spawners (Figure 11). The mean length of first-time spawners was 687 mm, of repeat spawners 764 mm, and of all wild fish was 692 mm (Table 4). A length frequency distribution of hatchery and wild steelhead is in Figure 12.

First time spawning hatchery fish were shorter at each ocean age than wild fish in both 1993 and 1994 (Table 5). Suspected gillnet-scars were observed on 13% of immigrant steelhead in 1993 (Appendix A2) and on 12% of 1994 immigrants (Appendix A5).

ANGLER EFFORT, CATCH, AND HARVEST SURVEYS

In 1993, 208 anglers were counted during the sampling period March 22 through May 30, and 200 anglers (96%) were interviewed (Table 6). Steelhead anglers fished an estimated total of 603 hours (SE = 25) to harvest 13 (SE = 3) hatchery and 4 (SE = 2) wild fish (Table 7). Six hatchery fish were aged in the creel survey; none of these had

Table 4.-Mean length at age of unique hatchery and wild steelhead at Ward Creek, 1994.

	Hatchery				Wild		
Age class	Length[a]	n	SE	Percent	Length[a]	SE	Percent
First-time spawners							
1.2	582	3	34	3			
1.3	719	60	6	65			
2.2	637	6	30	7	615	20	3
2.3					754	6	2
3.2					640	5	34
3.3					752	8	26
4.2					650	6	14
4.3					724	13	12
5.2					635		
R.2[b]	620	1		1			
R.3[b]					768	54	1
Subtotal	705	70	7	76	687	8	93
Repeat spawners							
1.2S1	691	5	54	5			
2.2S1S1	795	1		1			
2.3S1	749	8	46	9			
3.1S1					615		
3.2S1	595	1		1	668	48	1
3.3S1					837	6	1
4.2S1					820		
4.3S1					810	0	1
R.2S1[b]	720	1		1	830		
Subtotal	723	16	15	17	764	28	5
Unreadable		6		7			1
TOTAL[c]	708	92	7	100	692	5	100

[a] Mean of fork lengths measured to the nearest 5 mm.

[b] R = scales regenerated; freshwater age undetermined.

[c] Length data for fish with unreadable scales is not included.

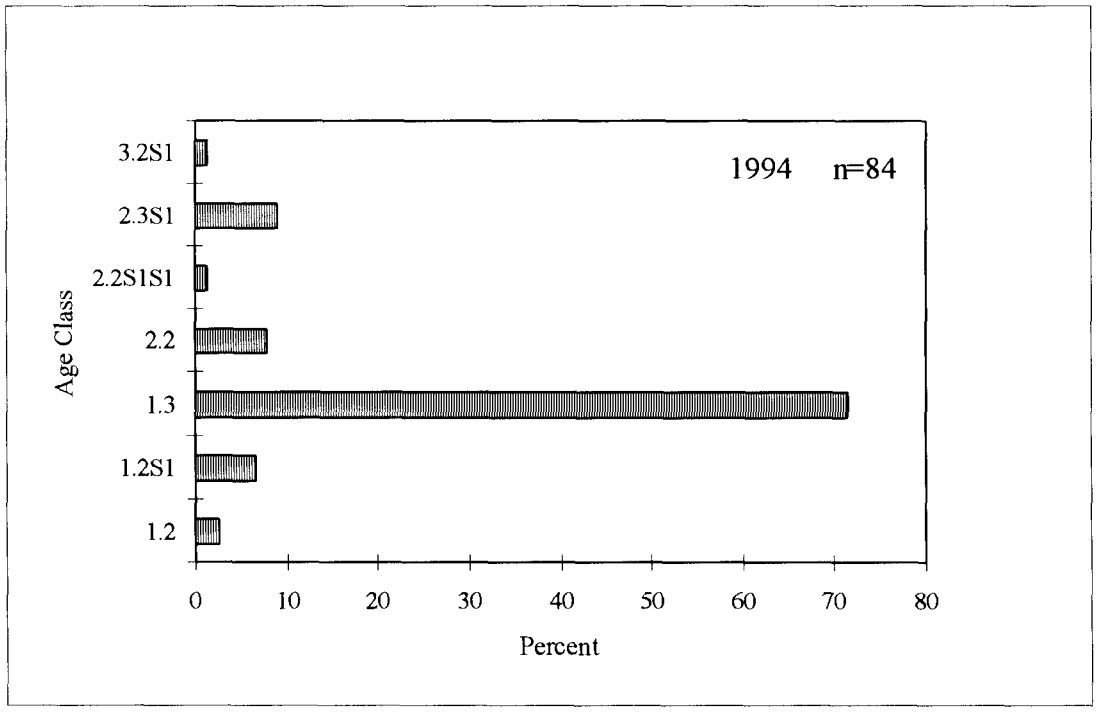

Figure 10.-Age classes of hatchery steelhead sampled at Ward Creek, spring 1994.

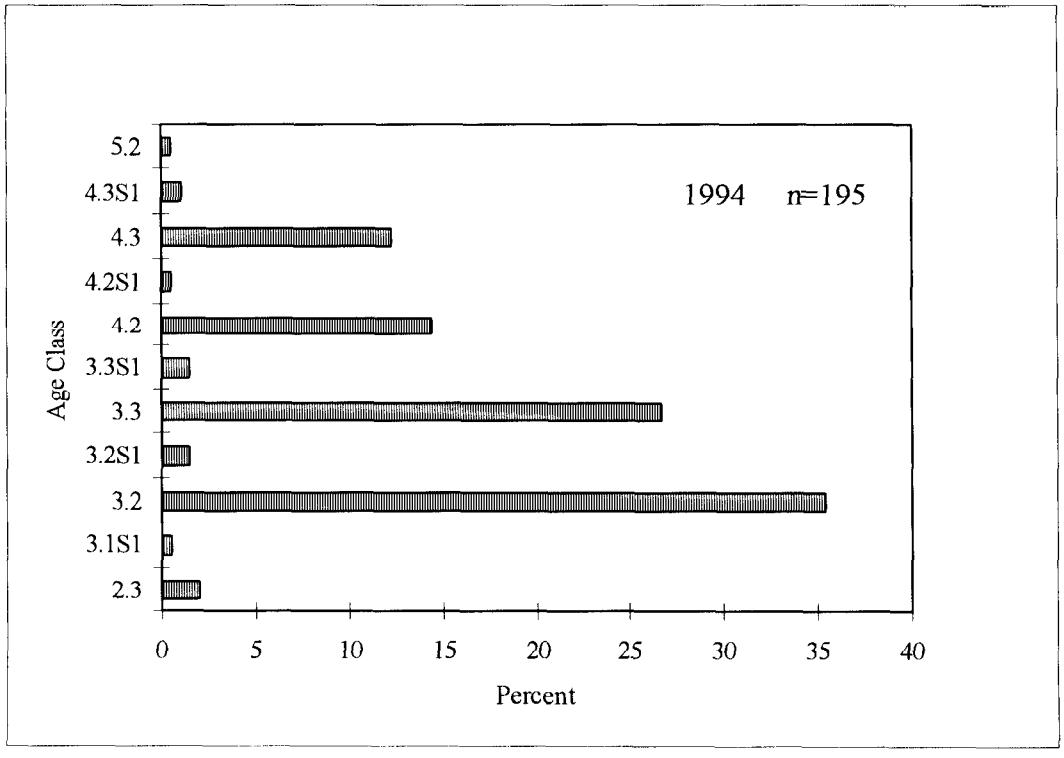

Figure 11.-Age classes of wild steelhead sampled at Ward Creek, spring 1994.

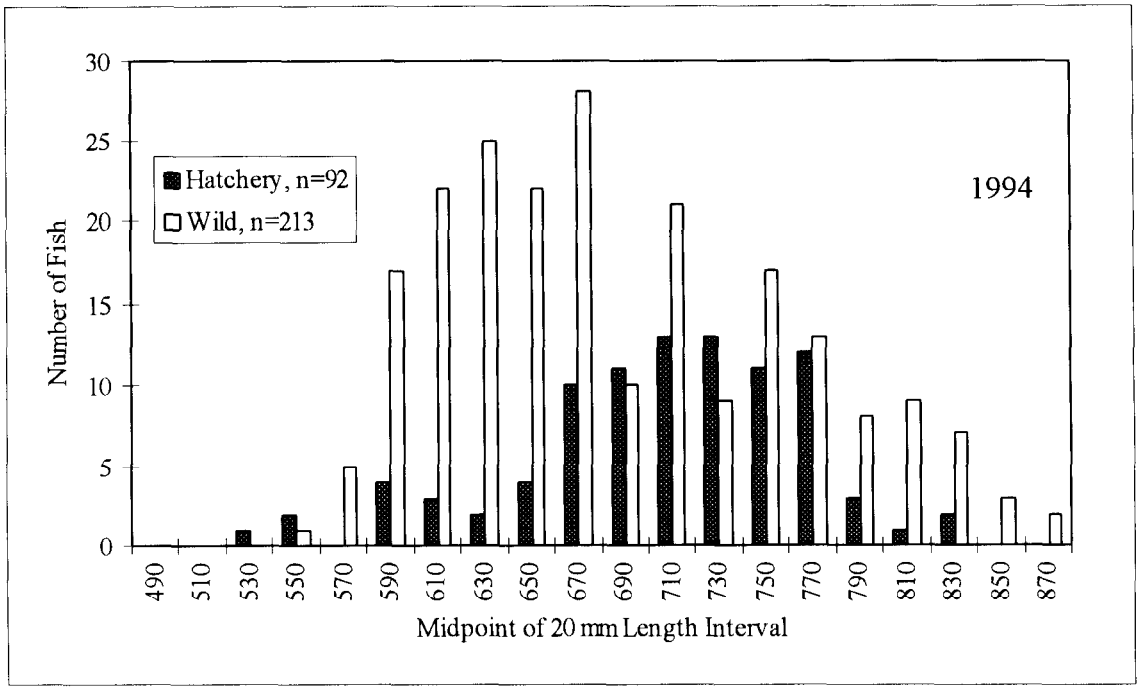

Figure 12.-Length frequency distribution of unique hatchery and wild steelhead sampled at Ward Creek, 1994.

Table 5.-Mean fork length at ocean age of hatchery and wild steelhead at Ward Creek, 1993-1994.

	Hatchery			Wild		
	Mean Length	SE	n[a]	Mean Length	SE	n[a]
1993						
Age .2	599	6	22	630	11	20
Age .3	716	18	25 (8)	758	7	46 (38)
Age .4	730	26	7	810	17	4
1994						
Age .2	614	8	27	641	4	106 (105)
Age .3	714	7	62 (57)	744	7	88 (83)
Age .4	718	16	8	826	12	5

[a] Number of fish which returned initially to spawn are shown in parentheses, if different.

Table 6.-Anglers sampled, estimated total angler effort, harvest, and releases by week in the 1993 spring steelhead sport fishery at Ward Creek.

Weekly	Anglers	Effort		Hatchery		Wild		Combined	
Period	Sampled[a]	Hours	SE	Kept	SE	Kept	SE	Released	SE
03/22-03/28	6/ 6	34	8	2	2	0	0	0	0
03/29-04/04	7/ 7	20	9	0	0	0	0	0	0
04/05-04/11	24/22	68	12	0	0	0	0	5	2
04/12-04/18	26/25	56	8	3	1	0	0	1	0
04/19-04/25	17/17	46	5	2	1	0	0	1	0
04/26-05/02	67/63	210	8	3	1	4	2	14	5
05/03-05/09	43/42	126	13	3	1	0	0	2	2
05/10-05/16	8/ 8	24	4	0	0	0	0	1	1
05/17-05/23	7/ 7	14	6	0	0	0	0	0	0
05/24-05/30	3/ 3	5	2	0	0	0	0	0	0
TOTALS	208/200	603	25	13	3	4	2	24	6

[a] Steelhead anglers counted / interviewed.

Table 7.-Estimated steelhead harvest, catch, and effort at Ward Creek during the springs of 1993 and 1994.

	Hatchery		Wild		Combined		Effort	
	Kept[a]	SE[a]	Kept[b]	SE	Released	SE	Hours	SE
1993	13 (5)	3 (1)	4	2	24	6	603	25
1994	14 (12)	3 (3)	0		102	11	1,243	58

[a] The estimates of hatchery 1991 releases are shown in parentheses.

[b] By emergency order, wild steelhead could not be legally harvested from May 12-December 31, 1993, and use of bait and barbed hooks was prohibited; by regulation, effective April 1, 1994, only one wild steelhead daily and two per season > 36 inches (914 mm) could be harvested, and the use of bait was prohibited.

been observed at the weir, and two of the six were from the 1991 release. The total harvest from the 1991 release in the study period was estimated at 5 (SE = 1) steelhead. Anglers caught an estimated total of 41 (SE = 7) steelhead, 24 (SE = 6) of which were released, for a release rate of 59%, and a catch rate of 14.7 hours fished per steelhead caught.

In 1994, 412 of 434 observed anglers (95%) were interviewed from March 14 through May 22 (Table 8). Steelhead anglers fished an estimated 1,243 hours (SE = 58) to harvest 14 (SE = 3) hatchery and no wild fish (Table 7). Seven hatchery fish were sampled in the creel survey; five (71%) of these had not been observed at the weir, and four of the five were from the 1991 release. Total harvest from the 1991 release in the study period was estimated to be 14 (SE = 3) steelhead. Anglers caught an estimated total of 116 (SE = 11) steelhead. The estimated release rate was 88%, and the catch rate was 10.7 hours per fish.

Table 8.-Estimated steelhead angler effort, catch, and harvest in the 1994 spring steelhead sport fishery at Ward Creek.

Weekly	Anglers	Effort		Hatchery		Wild		Combined	
Period	Sampled[a]	Hours	SE	Kept	SE	Kept	SE	Released	SE
03/14-03/20	8/7	36	9	3	3	0	0	0	0
03/21-03/27	35/31	91	25	0	0	0	0	0	0
03/28-04/03	29/27	52	4	0	0	0	0	4	2
04/04-04/10	14/12	28	7	0	0	0	0	1	1
04/11-04/17	62/61	184	26	5	2	0	0	30	6
04/18-04/24	50/50	139	13	0	0	0	0	14	4
04/25-05/01	76/76	215	22	0	0	0	0	14	3
05/02-05/08	68/67	221	27	4	1	0	0	22	3
05/09-05/15	57/53	162	20	1	1	0	0	17	7
05/16-05/22	35/28	115	12	0	0	0	0	0	0
TOTALS	434/412	1,243	58	14	3	0	0	102	11

[a] Steelhead anglers counted / interviewed.

TOTAL RETURN OF 1990 BROODSTOCK

Based on mark-recapture experiments conducted in 1993 and 1994, the estimated total number of steelhead from the 1991 release that returned to Ward Creek was 125 (SE=10) fish (33 in 1992/93 and 92 in 1993/94), about 17% of all fish that returned to the system during those two years (Table 9). This estimate does not include an unknown number of fish that returned during this period but died before being encountered at the weir.

COSTS

The estimated cost to produce and plant steelhead in Ward Lake in 1991 was $9,736 (Table 10). This figure is based on a total cost for operating the Klawock Hatchery of $553,000 (including $27,000 specifically for steelhead); a total weight for all fish produced of 31,475 kg, of which 554 kg (12,047 fish stocked at 46g each) were steelhead. Since an estimated 125 fish from the 1991 release returned to Ward Creek, the cost per returning adult was $77.89 ($9,736/125). Furthermore, of 125 fish that returned, 17 were harvested (5 in 1993 and 12 in 1994) representing a cost per fish harvested of $572.71 (9,736/17).

Table 9.-Estimated number and composition of steelhead returning to Ward Creek, fall 1992 through spring 1994.

Return	Hatchery Returns			
Year	1991 Release	Other Releases	Wild	Total[b]
1992/93				
Number	33	54	250	337
SE	7	13	49	51
%[a]	10%	16%	74%	100%
1993/94				
Number	92	17	302	412
SE	7	3	9	12
%[a]	22%	4%	73%	100%
Total				
Number	125	71	552	749
SE	10	13	50	53
%[a]	17%	10%	74%	100%

[a] Percent composition of total steelhead return.

[b] Sum of items may not equal true total due to rounding error.

Table 10.-Estimated costs of selected State hatchery-produced anadromous steelhead, coho and chinook salmon smolts released in Southeast Alaska.

Stocking Cohort and Release Year	Estimated Cost Per Fish			
	Mean Weight (g)	Total Return	Fish Harvested by Sport Anglers	All Fish Harvested
Steelhead				
Klawock River, 1 year-old smolt (Released at Ward Creek, 1991; only production costs included)	46.0	$77.89	$572.71	[a]
Crystal Creek, 2-year-old smolt (1983)[b]	47.4	$64.59	$185.48	[a]
Crystal Creek, 2-year-old smolt (1984)[b]	29.0	$67.22	$717.00	[a]
Coho Salmon[b]				
Salmon Creek (1987 smolt)	3.5	----	---[c]	$926.60
Fish Creek (1987 smolt)	7.8	----	$453.83	$55.57
Fish Creek (1988 smolt)	12.3	----	$54.72	$6.32
Dredge Lake (1987 smolt)	3.4	----	$45.21	$5.97
Dredge Lake (1988 smolt)	6.8	----	$78.85	$5.80
Sheep Creek (1988 smolt)	10.9	----	$67.04	$4.92
Chinook Salmon[b]				
Montana Creek (1986 smolt)	8.4	----	$1,396.40	$581.83
Fish Creek (1986 smolt) direct release	7.5	----	$1,347.40	$280.71
Fish Creek (1986 smolt) held, fed, and imprinted	8.4	----	$81.19	$46.40
Auke Creek (1986 smolt) direct release	8.0	----	$79.90	$57.91
Auke Creek (1986 smolt) held and fed	9.0	----	$42.78	$28.36
Auke Creek (1986 smolt) held, fed, and imprinted	9.1	----	$79.38	$36.81
Sheep Creek (1986 smolt)	7.7	----	$47.17	$17.49

[a] No estimates of the number of hatchery produced steelhead harvested in commercial fisheries were available.

[b] All information, including cost figures, shown is from Bentz, et al. (1991).

[c] Estimated harvest by sport anglers was zero.

DISCUSSION

Fish released into Ward Lake in 1991 averaged 46g, slightly greater than the desired weight of 45 g. However, their mean fork length of 160 mm was 10 mm shorter than the goal of 170 mm. The fork length of the estimated 1,318 fish (11%) which residualized averaged 148 mm, indicating that fish which failed to smolt were smaller than average. These fish remained in the system, and, because they were somewhat larger than wild juveniles, may have competed with wild fish for food and space. The distribution of wild juvenile steelhead captures indicates a preference for stream habitat, at least during summer: 97% of wild steelhead <110 mm and 79% of wild steelhead ≥110 mm were captured in Ward Creek (Freeman 1992). Residualized hatchery fish, however were almost equally abundant in stream and lake habitats. The residualized hatchery fish which inhabit stream habitats may out compete wild

juvenile steelhead, especially the smaller ones, for available food and space.

Estimates of return from mark-recapture experiments may have underestimated the returns of hatchery and wild fish. These methods estimate the number of fish alive at the time that fish were marked in the spring, e.g., an estimate of the total number of spring migrants plus pre-weir-installation migrants (fall-run and early spring-run fish). Fishing and natural mortality may have reduced the latter. Some fall fish may have been harvested during the fall, winter, or spring prior to installation of the weir. However, Hubartt 1990 showed that the harvest of steelhead in the months before installation of the weir (e.g., fall and winter of 1988/89) was only 9% of the harvest of that fall/spring return. If angler effort was similar in 1993 and 1994, I expect that fall/winter harvests in those years was negligible. Also, because fall-run fish reside in Ward Creek throughout the winter, they may have higher rates of natural or post-spawning mortality than spring-run fish. Such mortality may cause abundance estimates to be biased low. Our study was not designed to examine these factors and we collected no data to estimate these effects. Nevertheless, because there were few "pre-weir fish" in 1993/94 these effects should have been negligible.

Based on examination of emigrants at the weir in 1994, one-third of the estimated population or 136 (=81/244*412) fish had not been marked at the weir and were assumed to be "pre-weir" (i.e., fall-run and early spring-run) fish. The pre-weir population contained a higher proportion of hatchery fish than the spring run. Of *unmarked emigrants* (Table 2) inspected at the weir, 43% (=36/84) were of hatchery origin and of *unmarked immigrants* inspected at the weir, 19% (=53/273) were of hatchery origin. Finally, of all hatchery fish that returned in 1993/94, an estimated 54% (=59/110) arrived prior to weir installation.

Adult return rates from the 1991 hatchery release (estimated at 1%) were clearly quite low. Projected returns for steelhead produced in State fish hatcheries in Southeast Alaska have generally ranged from 3 to 6% (C. Denton, Alaska Department of Fish and Game, Ketchikan, personal communication). Fish from the 1991 release constituted an estimated 17% of the total steelhead return from fall 1992 through spring 1994. Considering these were from the largest one-year-old smolt ever released at Ward Creek, the returns were disappointing.

The observed low steelhead (hatchery and wild) return in 1993 was echoed in the sport fishery, where effort, harvest, and catch were low. Anglers fished 14.7 hours per steelhead (hatchery and wild) caught in 1993, and an estimated 26.2 hours per hatchery fish caught (Table 11). Anglers reported general frustration with the Ward Creek steelhead fishery in 1993. Angler effort more than doubled in 1994, and fishing improved to 10.7 hours per (hatchery and wild) fish caught. However, the disparity between wild and (lower) hatchery returns resulted in an estimated 33.6 hours fished per hatchery fish caught (Table 11). The estimated hatchery steelhead harvest was essentially the same in the spring 1993 and 1994 fisheries because of a higher release rate in 1994 (88%) than in 1993 (59%).

In comparison, anglers expended an estimated 101.6 hours to catch a hatchery fish at Ward Creek in spring 1988 (Hubartt 1989) and 56.6 hours to catch a hatchery fish in spring 1989 (Hubartt 1990; Table 11). Anglers were much more effective at catching wild steelhead than hatchery steelhead in 1988-89, and CPUE for catching wild steelhead in 1993-94 was much lower than the CPUE in 1988-89. Steelhead effort was much higher in 1988-89 than in 1993-94 (Table 11). Factors contributing most to the decreased effort likely included

fewer returning fish and more restrictive regulations in 1993-94.

The increased catch rate from 1988-89 to 1993-94 for hatchery fish and decreased catch rate for wild fish suggests declining abundance of wild fish relative to hatchery releases or declining production of wild fish relative to hatchery releases. Hubartt (1989) estimated that 359 steelhead were harvested in the Ward Creek system in spring 1988 and 384 from fall 1988 to spring 1989 (Hubartt 1990). Based on data from the Alaska Statewide Harvest Survey (Mills 1979-1992), the average annual steelhead harvest at Ward Creek from 1982 to 1991 was 310 fish, and harvests exceeded 400 fish in four of the ten years (Appendix A7). At Sitkoh Creek, a watershed of similar size on Baranof Island in northern Southeast Alaska, the annual escapement of steelhead was 770 and 661 during 1982 and 1990 respectively (Schmidt 1992). If escapements to Ward Creek were similar, then annual harvest rates may have averaged 43% (=309/715) of the annual returns during that decade. This analogy is purely speculative and untested, however it provides a potential scenario worthy of consideration.

The pattern of harvests at Ward Creek since the mid-1980s suggests overfishing of wild fish. In addition, there is also evidence of a local decline in steelhead production as indicated by declines in freshwater harvests for the Ketchikan area (see Figure 2). The degree to which production of steelhead is governed by these broader dynamics is not known.

The cost per steelhead returned (from the 1991 release) at Ward Creek was higher than releases from Crystal Lake Hatchery, near Petersburg, where two-year-old smolt were planted in 1983 and 1984 (Table 10). Returns from the Crystal Lake Hatchery releases totaled 3.4% from the 1983 release (47.4 g) and 1% in 1984 (29.0 g) (Bentz, et al. 1991).

Very low returns of adult hatchery fish released in 1992 were also evident during this study. Though 9,632 smolt with a mean weight of 41 g were released into Ward Creek in 1992, only 3 age-1.2 steelhead (mean fork length of 582 mm) were encountered in 1994 (Figure 10). This suggests either a very low total adult return, a high rate of fish remaining in freshwater an additional year before smolting, or possibly a greater number of older fish (e.g., may be expected to return in future years.

RECOMMENDATIONS

The results of this three-year study indicate that the Ward Creek steelhead fishery is mostly supported by natural production. The hatchery steelhead released in 1991 produced low returns in 1993 and 1994, and overall cost per fish returned was higher than returns of two-year-old smolt released from Crystal Lake

Table 11.-Steelhead effort (hours/fish) per wild and hatchery steelhead caught at Ward Creek at comparable time periods in the springs of 1988, 1989, 1993, and 1994.

Year of	Hours of effort per steelhead caught			
Survey	Hatchery	Wild	Combined Total	Effort (hrs)
1988[a]	101.6	2.6	2.7	3,251
1989[b]	56.6	7.6	6.7	4,130
1993	26.2	60.3	14.7	603
1994	33.6	15.5	10.7	1,243

[a.] Hubartt 1989.

[b.] Hubartt 1990.

Hatchery in 1983 and 1984. Results of this study confirm previous studies at Ward Creek, which also indicated that direct hatchery contribution to the sport fishery was low.

Overall adult steelhead returns are below those experienced in the late 1980s. Current regulations which restrict the harvest of wild steelhead should remain in place to conserve and rebuild the naturally producing stock. Introductions of hatchery reared steelhead in Ward Creek should be discontinued because of documented low returns, relatively high production costs, and the potential for competition between planted fish and wild fish.

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APPENIDX A. WARD CREEK STEELHEAD DATA

Appendix A1.-Daily count of unique steelhead passing the Ward Creek weir and water conditions, spring 1993.

Date	Upstream Counts (Hatchery) Daily	Cum.	Upstream Counts (Wild) Daily	Cum.	Downstream Counts (Hatchery) Daily	Cum.	Downstream Counts (Wild) Daily	Cum.	Water Temp.[a] (°C)	Water Level[a] (cm)
1 April	0	0	0	0	0	0	0	0	5.0	38.0
2 April	0	0	0	0	0	0	0	0	4.0	47.0
3 April	0	0	0	0	0	0	0	0	6.0	40.5
4 April	0	0	0	0	0	0	0	0	4.0	40.5
5 April	0	0	0	0	0	0	0	0	6.0	40.5
6 April	2	2	1	1	0	0	0	0	6.0	39.5
7 April	1	3	1	2	0	0	0	0	6.0	37.5
8 April	1	4	0	2	0	0	0	0	6.0	59.5
9 April	0	4	2	4	0	0	0	0	6.0	49.5
10 April	1	5	0	4	0	0	0	0	6.0	48.5
12 April	1	6	1	5	0	0	0	0	6.0	45.5
13 April	0	6	1	6	0	0	0	0	6.0	47.0
15 April	0	6	2	8	1	1	0	0	6.0	45.5
16 April	0	6	1	9	1	2	0	0	7.0	45.5
17 April	1	7	0	9	0	2	0	0	6.0	48.5
18 April	1	8	0	9	0	2	1	1	7.0	48.0
20 April	1	9	2	11	0	2	0	1	7.0	43.0
21 April	0	9	1	12	0	2	0	1	8.0	40.5
22 April	0	9	0	12	1	3	0	1	8.0	40.5
23 April	0	9	1	13	0	3	0	1	10.0	40.5
24 April	0	9	1	14	0	3	0	1	10.0	40.5
25 April	0	9	1	15	0	3	1	2	10.0	42.0
26 April	2	11	1	16	0	3	0	2	10.0	42.0
27 April	1	12	5	21	2	5	3	5	11.0	43.0
28 April	1	13	2	23	5	10	1	6	8.0	54.5
29 April	2	15	6	29	4	14	0	6	8.0	67.5
30 April	0	15	2	31	1	15	1	7	8.0	71.0
1 May	5	20	8	39	0	15	0	7	7.0	134.5
2 May	1	21	3	42	2	17	0	7	7.0	96.5
3 May	0	21	6	48	0	17	0	7	7.0	78.5
6 May	1	22	0	48	0	17	0	7	7.0	119.5
7 May	0	22	5	53	0	17	0	7	7.0	89.0
8 May	0	22	2	55	0	17	0	7	7.0	68.5

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Appendix A1.-Page 2 of 2.

Date	Upstream Counts (Hatchery) Daily	Upstream Counts (Hatchery) Cum.	Upstream Counts (Wild) Daily	Upstream Counts (Wild) Cum.	Downstream Counts (Hatchery) Daily	Downstream Counts (Hatchery) Cum.	Downstream Counts (Wild) Daily	Downstream Counts (Wild) Cum.	Water Temp.[a] (°C)	Water Level[a] (cm)
9 May	2	24	2	57	0	17	1	8	8.0	66.0
10 May	0	24	4	61	0	17	0	8	8.0	54.5
11 May	0	24	3	64	0	17	1	9	8.0	48.5
12 May	2	26	3	67	0	17	1	10	10.0	44.0
13 May	2	28	2	69	0	17	0	10	12.0	42.0
15 May	0	28	2	71	0	17	3	13	14.0	39.5
16 May	0	28	1	72	1	18	2	15	14.0	39.0
17 May	0	28	1	73	2	20	0	15	13.0	38.0
18 May	0	28	0	73	0	20	3	18	13.0	38.0
19 May	0	28	0	73	3	23	0	18	15.0	38.0
20 May	0	28	0	73	1	24	3	21	14.0	37.5
21 May	1	29	0	73	2	26	0	21	14.0	38.0
22 May	0	29	0	73	2	28	2	23	13.0	38.0
23 May	0	29	1	74	0	28	6	29	13.0	38.0
24 May	0	29	0	74	1	29	3	32	14.0	38.0
25 May	1	30	1	75	1	30	2	34	15.0	38.0
26 May	0	30	1	76	0	30	1	35	16.0	37.0
27 May	0	30	0	76	0	30	1	36	16.0	37.5
28 May	0	30	0	76	0	30	2	38	17.0	35.5
30 May	0	30	0	76	1	31	0	38	17.0	35.5
31 May	0	30	0	76	1	32	0	38	16.0	35.5
1 June	0	30	0	76	0	32	1	39	17.0	35.0
2 June	0	30	1	77	1	33	3	42	16.0	35.5
4 June	0	30	1	78	0	33	1	43	17.0	33.0
5 June	0	30	1	79	0	33	0	43	17.0	29.0

[a] Water temperature and level measured at 0800 hours.

Appendix A2.-Date, origin (hatchery or wild stock), sex, fork length, age, brood year, and scars of unique adult steelhead passed upstream through the Ward Creek weir, spring 1993.

Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
6 April	Hatchery		570	1.2	**1990**	
6 April	Hatchery	F	750	2.2S1	1988	
6 April	Wild		615	3.2	1988	
7 April	Wild		760	4.2S1	1986	
7 April	Hatchery		585	1.2	**1990**	
8 April	Hatchery	M	615	1.2	**1990**	
9 April	Wild		660	4.2	1987	
9 April	Wild		765	3.3	1987	
10 April	Hatchery		770	2.3S1	1987	H
12 April	Wild		775	4.3	1986	H
12 April	Hatchery		843	R.3S1	Unknown	
13 April	Wild	M	790	4.3	1986	
15 April	Wild	M	795	4.3	1986	
15 April	Wild		630	3.2	1988	
16 April	Wild		725	4.3	1986	
17 April	Hatchery		590	1.2	**1990**	
18 April	Hatchery		755	R.2S1	Unknown	H
20 April	Wild	M	680	3.2	1988	
20 April	Wild		640	R.2	Unknown	
20 April	Hatchery		760	R.2S1	Unknown	
21 April	Wild		620	4.3	1986	
23 April	Wild	F	780	4.2S1	1986	
24 April	Wild	F	815	4.3	1986	
25 April	Wild		760	3.3S1	1986	
26 April	Hatchery	M	555	1.2	**1990**	
27 April	Hatchery	M	565	1.2	**1990**	
27 April	Wild		710	4.3	1986	
27 April	Hatchery	M	810	1.3S1	1988	
27 April	Wild	F	780	3.3	1987	F
27 April	Wild		765	3.2	1988	
27 April	Wild	F	750	3.2S1	1987	
27 April	Wild		775	3.2S1	1987	
27 April	Wild	M	795	3.3	1987	
28 April	Hatchery		610	1.2	**1990**	
28 April	Wild	M	585	4.2	1987	
28 April	Wild	F	820	3.2S1S1	1986	
29 April	Hatchery	M	750	R.3	Unknown	H

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Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
29 April	Wild	M	850	4.3	1986	
29 April	Wild	F	705	3.3	1987	
29 April	Wild	F	705	3.3	1987	
29 April	Wild	M	795	4.3	1986	
29 April	Wild	F	785	4.3	1986	
29 April	Hatchery	M	860	3.2S1	1987	
29 April	Wild	F	775	3.3	1987	
30 April	Wild	F	835	4.3S1	1985	
30 April	Wild	M	775	3.3	1987	
1 May	Hatchery	F	800	Unreadable	Unknown	
1 May	Hatchery		740	R.2S1	Unknown	
1 May	Hatchery		640	1.2	**1990**	
1 May	Hatchery	F	740	R.2S1	Unknown	
1 May	Wild	F	620	3.3	1987	
1 May	Hatchery	F	775	R.2S1	Unknown	
1 May	Wild		560	3.2	1988	
1 May	Wild		----	----	Unknown	
1 May	Wild		----	----	Unknown	
1 May	Wild		----	----	Unknown	
1 May	Wild		----	----	Unknown	
1 May	Wild		----	----	Unknown	
1 May	Wild		----	----	Unknown	
2 May	Wild	F	680	----	Unknown	
2 May	Wild	F	750	----	Unknown	
2 May	Wild	F	500	----	Unknown	
2 May	Hatchery	F	----	----	Unknown	
3 May	Wild	M	730	3.2S1	1987	
3 May	Wild		630	R.2	Unknown	
3 May	Wild	M	700	4.3	1986	H
3 May	Wild	F	770	4.3	1986	H
3 May	Wild	F	780	4.3	1986	H
3 May	Wild	F	670	4.3	1986	H
6 May	Hatchery	M	640	1.2	**1990**	
7 May	Wild	M	800	4.2S1	1986	
7 May	Wild	F	730	4.3	1986	H
7 May	Wild	M	715	4.3	1986	
7 May	Wild	F	530	3.2	1988	
7 May	Wild		705	4.3	1986	

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Appendix A2.-Page 3 of 3.

Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
8 May	Wild	M	760	3.3	1987	
8 May	Wild	F	775	4.3	1986	
9 May	Hatchery	F	730	----	Unknown	H
9 May	Wild		810	3.3	1987	
9 May	Hatchery	M	620	1.2	**1990**	
9 May	Wild	F	760	3.3	1987	
10 May	Wild	M	635	2.2	1989	
10 May	Wild	M	625	2.2	1989	
10 May	Wild	F	700	3.3	1987	F
10 May	Wild	M	830	3.3	1987	
11 May	Wild	F	730	3.3	1987	
11 May	Wild	M	830	3.3	1987	
11 May	Wild	F	825	3.3S1	1986	
12 May	Hatchery	F	750	3.2S1	1987	
12 May	Wild	M	620	R.2	Unknown	
12 May	Wild	M	635	3.2	1988	
12 May	Wild	F	820	3.3	1987	
12 May	Hatchery	M	625	3.2	1988	
13 May	Hatchery	M	620	1.2	**1990**	
13 May	Wild	M	600	4.2	1987	
13 May	Hatchery		625	1.2	**1990**	
13 May	Wild	M	780	3.3	1987	
15 May	Wild	M	745	3.2S1	1987	
15 May	Wild	F	640	3.2	1988	
16 May	Wild	M	790	2.2S1	1988	
17 May	Wild	M	655	R.2	Unknown	
21 May	Hatchery	F	665	R.2S1	Unknown	
23 May	Wild	F	800	4.3	1986	
25 May	Wild	F	570	4.2	1987	
25 May	Hatchery	F	800	2.2S1	1988	
26 May	Wild	F	710	3.3	1987	F
2 June	Wild	F	780	4.3	1986	
4 June	Wild	F	690	4.2	1987	
5 June	Wild	F	630	3.2	1988	H

[a] F = female, M = male.

[b] Fish with suspected gillnet marks, as identified in ADF&G (*unpublished*) and by D. Wood, Alaska Department of Fish and Game, Sitka, personal communication. F=fresh and H=healed scar.

Appendix A3.-Date, origin (hatchery or wild stock), sex, fork length, age, and brood year of adult steelhead passed downstream through the Ward Creek weir and steelhead harvested in the creel survey, spring 1993.

Date	Hatchery/Wild	Sex[a]	FL (mm)	Age	Brood Year	Creel[b]	Upstream[c]
22 March	Hatchery	M	670	R.2S1	Unknown	X	
4 April	Hatchery	M	600	1.2	**1990**	X	
15 April	Hatchery		550	2.3	1988		
16 April	Hatchery		620	1.2	**1990**	X	
17 April	Hatchery		580	1.2	**1990**		
17 April	Hatchery	M	840	2.2S1	1988	X	
18 April	Wild		----	----	Unknown		
22 April	Hatchery						X
25 April	Wild		----	----	Unknown		
25 April	Hatchery[d]	M	585	1.2	**1990**	X	
27 April	Wild		----	----	Unknown		
27 April	Hatchery	M	830	----	Unknown		
27 April	Hatchery						X
27 April	Wild		----	----	Unknown		
27 April	Wild		----	----	Unknown		
28 April	Hatchery		780	3.2S1	1987		
28 April	Hatchery	M	660	R.2	Unknown		
28 April	Hatchery	M					X
28 April	Hatchery	F	590	1.2	**1990**		
28 April	Wild		----	----	Unknown		
28 April	Hatchery	M	730	R.2S1S1	Unknown		
28 April	Hatchery	M	775	2.2S1	1988	X	
28 April	Wild	F	825	3.2S1	1987	X	
29 April	Hatchery		690	2.2S1	1988		
29 April	Hatchery	M	700	R.2S1	Unknown		
29 April	Hatchery	M	560	1.2	**1990**		
29 April	Hatchery	F	550	R.3	Unknown		
30 April	Hatchery	F	830	2.2S1S1	1987		
30 April	Wild		----	----	Unknown		
2 May	Hatchery						X
2 May	Hatchery	M	585				X
2 May	Hatchery	F	735	R.3	Unknown	X	
2 May	Wild	M	650	3.2	1988	X	
9 May	Wild		----	----	Unknown		
11 May	Wild		----	----	Unknown		
12 May	Wild		----	----	Unknown		
14 May	Wild[e]	F	765	4.2S1	1986		

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Appendix A3.-Page 2 of 2.

Date	Hatchery/Wild	Sex[a]	FL (mm)	Age	Brood Year	Creel[b]	Upstream[c]
15 May	Wild		----	----	Unknown		
15 May	Wild	M	----	----	Unknown		
15 May	Wild	M	----	----	Unknown		
16 May	Hatchery	M	660	R.3	Unknown		
16 May	Wild		----	----	Unknown		
16 May	Wild						X
17 May	Hatchery	F	645	R.3S1	Unknown		
17 May	Hatchery	F	805	2.3S1	1987		
18 May	Wild		----	----	Unknown		
18 May	Wild		----	----	Unknown		
18 May	Wild		----	----	Unknown		
19 May	Hatchery	F	785	R.3	Unknown		
19 May	Hatchery	M	610	1.2	**1990**		
19 May	Hatchery		730	R.2S1	Unknown		
20 May	Wild		----	----	Unknown		
20 May	Hatchery						X
20 May	Wild		----	----	Unknown		
21 May	Hatchery	M	545	1.2	**1990**		
21 May	Hatchery						X
22 May	Wild		----	----	Unknown		
22 May	Wild		----	----	Unknown		
22 May	Hatchery						X
22 May	Hatchery						X
23 May	Wild		----	----	Unknown		
23 May	Wild		----	----	Unknown		
24 May	Hatchery						X
24 May	Wild		----	----	Unknown		
24 May	Wild		----	----	Unknown		
25 May	Hatchery		585	1.2	**1990**		
25 May	Wild		----	----	Unknown		
27 May	Wild		----	----	Unknown		
28 May	Wild		----	----	Unknown		
29 May	Wild[e]	F	590	2.2	1989		X
30 May	Hatchery	M	540	R.3	Unknown		
31 May	Hatchery	M					X
2 June	Hatchery		550	2.3	1988		
2 June	Wild		----	----	Unknown		
4 June	Wild	M	----	----	Unknown		

[a] F = female, M = male.

[b] Steelhead harvested and sampled in creel survey; all other fish were sampled at weir.

[c] Steelhead previously passed upstream through the weir.

[d] Steelhead previously passed downstream (only) through the weir.

[e] Mortality recovered upstream of weir.

Appendix A4.-Daily count of unique steelhead passing the Ward Creek weir and water conditions, spring 1994.

Date	Upstream Counts (Hatchery) Daily	Upstream Counts (Hatchery) Cum.	Upstream Counts (Wild) Daily	Upstream Counts (Wild) Cum.	Downstream Counts (Hatchery) Daily	Downstream Counts (Hatchery) Cum.	Downstream Counts (Wild) Daily	Downstream Counts (Wild) Cum.	Water Temp.[a] (°C)	Water Level[a] (cm)
19 March	1	1	0	0	0	0	0	0	4	60.0
20 March	0	1	0	0	0	0	0	0	4	63.5
21 March	0	1	0	0	0	0	0	0	4	83.8
22 March	0	1	0	0	0	0	0	0	4	55.9
23 March	1	2	2	2	0	0	0	0	4	52.7
24 March	0	2	0	2	0	0	0	0	4	50.8
25 March	0	2	1	3	0	0	0	0	4	50.8
26 March	1	3	0	3	0	0	0	0	4	50.8
27 March	0	3	0	3	0	0	0	0	5	53.3
28 March	0	3	0	3	0	0	0	0	4	50.8
29 March	0	3	1	4	0	0	0	0	6	50.8
30 March	2	5	0	4	0	0	0	0	6	72.4
31 March	3	8	1	5	1	1	0	0	6	78.7
1 April	2	10	1	6	0	1	0	0	4	45.7
2 April	0	10	0	6	0	1	0	0	5	55.9
3 April	0	10	3	9	1	2	0	0	5	69.9
4 April	0	10	2	11	0	2	0	0	5	53.3
5 April	1	11	1	12	0	2	0	0	5	48.3
6 April	0	11	0	12	0	2	0	0	5	48.3
7 April	0	11	1	13	0	2	0	0	6	47.0
8 April	0	11	1	14	0	2	0	0	6	47.0
9 April	0	11	0	14	0	2	0	0	7	47.0
10 April	6	17	4	18	0	2	0	0	6	48.3
11 April	1	18	1	19	0	2	0	0	6	127.0
12 April	3	21	6	25	2	4	0	0	6	99.1
13 April	1	22	8	33	2	6	0	0	6	83.8
14 April	2	24	3	36	0	6	0	0	5	66.0
15 April	2	26	6	42	2	8	0	0	5	106.7
16 April	2	28	6	48	0	8	0	0	5	72.4
17 April	1	29	5	53	0	8	0	0	5	66.0
18 April	1	30	1	54	0	8	0	0	5	55.9
19 April	0	30	3	57	0	8	0	0	6	50.8
20 April	2	32	2	59	0	8	0	0	6	58.4

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Date	Upstream Counts (Hatchery) Daily	Upstream Counts (Hatchery) Cum.	Upstream Counts (Wild) Daily	Upstream Counts (Wild) Cum.	Downstream Counts (Hatchery) Daily	Downstream Counts (Hatchery) Cum.	Downstream Counts (Wild) Daily	Downstream Counts (Wild) Cum.	Water Temp.[a] (°C)	Water Level[a] (cm)
21 April	1	33	7	66	2	10	0	0	7	68.6
22 April	1	34	8	74	1	11	0	0	7	74.9
23 April	2	36	9	83	0	11	0	0	8	63.5
24 April	0	36	0	83	0	11	0	0	8	62.2
25 April	1	37	13	96	0	11	0	0	9	58.4
26 April	0	37	2	98	0	11	0	0	9	55.2
27 April	2	39	4	102	0	11	0	0	9	57.8
28 April	2	41	3	105	0	11	0	0	9	58.4
29 April	0	41	9	114	0	11	0	0	9	68.6
30 April	0	41	9	123	0	11	0	0	8	83.8
1 May	1	42	8	131	0	11	0	0	9	63.5
2 May	0	42	5	136	0	11	0	0	9	58.4
3 May	3	45	7	143	0	11	1	1	9	57.8
4 May	0	45	2	145	0	11	0	1	9	54.6
5 May	0	45	0	145	0	11	0	1	10	48.3
6 May	1	46	8	153	0	11	0	1	10	73.7
7 May	1	47	6	159	0	11	0	1	8	78.7
8 May	0	47	4	163	0	11	0	1	9	58.4
9 May	1	48	3	166	2	13	2	3	9	81.3
10 May	0	48	4	170	2	15	2	5	10	66.0
11 May	1	49	7	177	13	28	13	18	10	96.5
12 May	0	49	3	180	3	31	3	21	9	94.0
13 May	0	49	1	181	2	33	1	22	9	88.9
14 May	0	49	2	183	0	33	0	22	9	66.0
15 May	0	49	4	187	0	33	0	22	9	58.4
16 May	1	50	1	188	0	33	0	22	10	50.8
17 May	0	50	1	189	0	33	0	22	12	48.3
18 May	0	50	1	190	0	33	0	22	13	47.6
19 May	1	51	5	195	0	33	0	22	14	47.0
20 May	1	52	3	198	0	33	1	23	16	47.0
21 May	0	52	3	201	0	33	1	24	16	45.7
22 May	0	52	1	202	0	33	4	28	14	45.7
23 May	0	52	3	205	7	40	11	39	12	49.5

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Date	Upstream Counts (Hatchery) Daily	Cum.	Upstream Counts (Wild) Daily	Cum.	Downstream Counts (Hatchery) Daily	Cum.	Downstream Counts (Wild) Daily	Cum.	Water Temp.[a] (°C)	Water Level[a] (cm)
24 May	0	52	3	208	14	54	22	61	9	116.8
25 May	0	52	2	210	0	54	1	62	10	109.2
26 May	1	53	1	211	0	54	7	69	11	68.6
27 May	0	53	0	211	0	54	3	72	11	47.0
28 May	0	53	2	213	3	57	5	77	11	72.4
29 May	0	53	0	213	1	58	10	87	9	85.1
30 May	0	53	1	214	1	59	5	92	10	91.4
31 May	0	53	1	215	0	59	4	96	11	69.9
1 June	0	53	0	215	0	59	10	106	11	78.7
2 June	0	53	0	215	0	59	0	106	9	0.0
3 June	0	53	0	215	0	59	0	106	9	116.8
4 June	0	53	1	216	0	59	3	109	11	66.0
5 June	0	53	0	216	0	59	0	109	12	50.8
6 June	0	53	0	216	0	59	0	109	13	41.9
7 June	0	53	0	216	0	59	3	112	13	41.9
8 June	0	53	0	216	0	59	1	113	13	40.6
9 June	0	53	0	216	0	59	0	113	15	38.1
10 June	0	53	0	216	0	59	0	113	15	35.6
11 June	0	53	0	216	0	59	1	114	14	40.6
12 June	0	53	0	216	0	59	12	126	14	42.5
13 June	0	53	0	216	1	60	3	129	15	41.9
14 June	0	53	0	216	0	60	0	129	15	40.6
15 June	0	53	1	217	0	60	0	129	16	40.6
16 June	0	53	0	217	0	60	0	129	16	39.4
17 June	0	53	0	217	0	60	0	129	15	35.6
18 June	0	53	0	217	0	60	0	129	15	35.6
19 June	0	53	1	218	0	60	0	129	15	35.6
20 June	0	53	0	218	0	60	2	131	15	35.6
21 June	0	53	0	218	0	60	0	131	16	34.3
22 June	0	53	0	218	0	60	1	132	16	34.3
23 June	0	53	0	218	0	60	0	132	16	34.3
24 June	0	53	0	218	0	60	0	132	17	31.8
25 June	0	53	0	218	0	60	0	132	17	30.5

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Date	Upstream Counts (Hatchery) Daily	Cum.	Upstream Counts (Wild) Daily	Cum.	Downstream Counts (Hatchery) Daily	Cum.	Downstream Counts (Wild) Daily	Cum.	Water Temp.[a] (°C)	Water Level[a] (cm)
26 June	0	53	0	218	0	60	0	132	17	30.5
27 June	0	53	0	218	0	60	0	132	16	30.5
28 June	0	53	0	218	1	61	5	137	16	30.5
29 June	0	53	1	219	1	62	4	141	15	36.8
30 June	0	53	0	219	3	65	23	164	13	57.2
1 July	0	53	0	219	0	65	4	168	14	39.4
2 July	0	53	0	219	0	65	0	168	14	34.3
3 July	0	53	0	219	0	65	0	168	14	34.3
4 July	0	53	0	219	0	65	0	168	16	33.0
5 July	0	53	0	219	0	65	0	168	14	31.1
6 July	0	53	0	219	3	68	3	171	13	31.1
7 July	0	53	0	219	1	69	3	174	13	66.0
8 July	0	53	1	220	0	69	3	177	14	66.7
9 July	0	53	0	220	0	69	0	177	14	47.0
10 July	0	53	0	220	0	69	0	177	14	33.0

[a] Water temperature and level measured at 0800 hours.

Appendix A5.-Date, origin (hatchery or wild stock), sex, fork length, age, brood year, and scars of unique adult steelhead passed upstream through the Ward Creek weir, spring 1994.

Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
19 March	Hatchery	M	590	1.3	**1990**	
23 March	Hatchery	F	670	1.3	**1990**	
23 March	Wild	F	645	3.2	1989	
23 March	Wild	F	730	3.3	1988	H
25 March	Wild	M	680	R.3	Unknown	
26 March	Hatchery	F	720	Unreadable	Unknown	
29 March	Wild	M	655	3.2	1989	
30 March	Hatchery	M	620	Unreadable	Unknown	
30 March	Hatchery	F	710	1.3	**1990**	H
31 March	Hatchery	F	690	1.3	**1990**	
31 March	Hatchery	M	755	1.3	**1990**	
31 March	Hatchery	M	770	1.3	**1990**	
31 March	Wild	M	595	4.2	1988	
1 April	Hatchery	M	595	2.2	**1990**	
1 April	Hatchery	M	770	1.2S1	**1990**	
1 April	Wild	M	645	4.2	1988	
3 April	Wild	M	840	3.3	1988	
3 April	Wild	M	720	4.2	1988	
3 April	Wild	F	635	5.2	1987	
4 April	Wild	F	605	4.2	1988	
4 April	Wild	M	605	3.2	1989	
4 April	Wild	M	615	3.2	1989	H
5 April	Hatchery	F	730	1.3	**1990**	H
5 April	Wild	M	660	3.2S1	1988	
7 April	Wild	M	615	3.1S1	1989	
10 April	Hatchery	M	770	1.3	**1990**	H
10 April	Hatchery	M	780	2.3S1	1988	H
10 April	Hatchery	M	760	1.3	**1990**	H
10 April	Hatchery	M	750	1.3	**1990**	
10 April	Hatchery	M	780	1.3	**1990**	
10 April	Hatchery	F	695	1.3	**1990**	
10 April	Wild	M	695	4.2	1988	
10 April	Wild	F	770	3.2	1989	
10 April	Wild	M	650	3.2	1989	
10 April	Wild	M	670	3.2	1989	
11 April	Hatchery	F	720	1.3	**1990**	H
11 April	Wild	M	800	3.3	1988	H
12 April	Hatchery	M	795	2.2S1S1	1988	
12 April	Hatchery	F	755	2.3S1	1988	F
12 April	Hatchery	M	835	1.3	**1990**	
12 April	Wild	F	670	3.2	1989	
12 April	Wild	M	675	4.2	1988	
12 April	Wild	M	875	4.3	1987	H
12 April	Wild	M	790	----	Unknown	
12 April	Wild	M	605	----	Unknown	

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Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
12 April	Wild	F	680	----	Unknown	
13 April	Hatchery	F	665	1.3	**1990**	
13 April	Wild	F	705	4.3	1987	
13 April	Wild	M	675	3.2	1989	
13 April	Wild	M	620	3.2	1989	
13 April	Wild	F	720	4.3	1987	H
13 April	Wild	F	820	4.2S1	1987	
13 April	Wild	M	680	4.2	1988	
13 April	Wild	M	680	3.2	1989	
13 April	Wild	M	610	2.2	1990	
14 April	Hatchery	F	720	1.3	**1990**	
14 April	Hatchery	M	650	2.3S1	1988	
14 April	Wild	M	785	3.3	1988	
14 April	Wild	M	860	3.3	1988	
14 April	Wild	F	745	4.3	1987	
15 April	Hatchery	F	745	1.3	**1990**	
15 April	Hatchery	F	725	2.2	**1990**	
15 April	Wild	M	655	4.3	1987	
15 April	Wild	M	720	4.3	1987	H
15 April	Wild	M	650	4.2	1988	
15 April	Wild	M	650	4.3	1987	
15 April	Wild	F	710	4.3	1987	
15 April	Wild	F	595	3.2	1989	
16 April	Hatchery	F	755	1.3	**1990**	
16 April	Hatchery	F	675	1.3	**1990**	
16 April	Wild	F	720	3.2	1989	
16 April	Wild	F	720	3.3	1988	
16 April	Wild	F	565	3.3	1988	
16 April	Wild	M	625	3.2S1	1988	H
16 April	Wild	F	760	R.3	Unknown	H
16 April	Wild	M	720	3.2S1	1988	
17 April	Hatchery	F	710	1.3	**1990**	
17 April	Wild	M	585	3.2	1989	
17 April	Wild	F	795	3.3	1988	H
17 April	Wild	M	815	3.3	1988	
17 April	Wild	F	720	4.3	1987	
17 April	Wild	F	630	3.2	1989	
18 April	Hatchery	F	640	----	Unknown	
18 April	Wild	F	810	4.3	1987	H
19 April	Wild	M	665	4.2	1988	
19 April	Wild	M	630	3.2	1989	
19 April	Wild	M	620	3.3	1988	
20 April	Hatchery	F	795	Unreadable	Unknown	
20 April	Hatchery	M	600	2.2	**1990**	
20 April	Wild	F	630	3.2	1989	
20 April	Wild	M	650	4.2	1988	

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Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
21 April	Hatchery	F	715	1.3	**1990**	
21 April	Wild	M	640	4.2	1988	
21 April	Wild	M	670	3.2	1989	
21 April	Wild	F	660	3.2	1989	H
21 April	Wild	M	620	3.2	1989	
21 April	Wild	M	670	3.2	1989	
21 April	Wild	M	630	4.2	1988	
21 April	Wild	M	750	3.3	1988	
22 April	Hatchery	F	665	1.3	**1990**	
22 April	Wild	M	650	4.2	1988	
22 April	Wild	M	700	4.2	1988	
22 April	Wild	M	840	3.3S1	1987	
22 April	Wild	M	740	4.3	1987	
22 April	Wild	M	700	4.2	1988	
22 April	Wild	F	600	3.2	1989	
22 April	Wild	F	700	3.2	1989	
23 April	Hatchery	F	605	----	Unknown	
22 April	Wild	F	700	3.3	1988	
23 April	Hatchery	F	685	1.3	**1990**	H
23 April	Wild	F	720	3.3	1988	
23 April	Wild	F	650	3.2	1989	
23 April	Wild	M	670	4.2	1988	
23 April	Wild	M	840	4.3S1	1986	H
23 April	Wild	M	640	3.2	1989	
23 April	Wild	M	645	4.3	1987	
23 April	Wild	M	635	Unreadable	Unknown	
23 April	Wild	F	620	3.2	1989	
23 April	Wild	F	625	4.2	1988	
25 April	Hatchery	F	595	3.2S1	1988	
25 April	Wild	F	730	3.3	1988	
25 April	Wild	F	630	4.2	1988	
25 April	Wild	F	735	4.3	1987	H
25 April	Wild	M	700	4.3	1987	
25 April	Wild	F	670	4.3	1987	
25 April	Wild	F	760	3.3	1988	H
25 April	Wild	F	765	4.3	1987	
25 April	Wild	M	740	3.3	1988	
25 April	Wild	F	590	3.2	1989	
25 April	Wild	M	850	3.3	1988	
25 April	Wild	M	600	3.2	1989	H
25 April	Wild	F	600	4.2	1988	
25 April	Wild	F	830	R.2S1	Unknown	
26 April	Wild	M	800	4.3	1987	
26 April	Wild	M	660	3.2	1989	
27 April	Hatchery	F	730	Unreadable	Unknown	

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Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
27 April	Hatchery	M	550	2.2	**1990**	
27 April	Wild	F	660	4.2	1988	
27 April	Wild	F	610	3.2	1989	
27 April	Wild	M	710	3.3	1988	
27 April	Wild	F	715	3.3	1988	
28 April	Hatchery	M	620	2.2	**1990**	
28 April	Hatchery	M	770	1.3	**1990**	
28 April	Wild	F	770	3.3	1988	
28 April	Wild	F	670	4.3	1987	
28 April	Wild	F	630	3.2	1989	
29 April	Wild	M	610	3.2	1989	
29 April	Wild	M	570	2.2	1990	
29 April	Wild	F	605	3.2	1989	
29 April	Wild	M	815	3.3	1988	
29 April	Wild	M	805	3.3	1988	
29 April	Wild	M	670	4.2	1988	
29 April	Wild	F	760	3.3	1988	
29 April	Wild	M	675	3.2	1989	
29 April	Wild	M	760	4.3	1987	
30 April	Wild	M	720	3.3	1988	
30 April	Wild	M	650	3.2	1989	
30 April	Wild	F	630	3.2	1989	
30 April	Wild	M	605	3.2	1989	
30 April	Wild	M	675	3.2	1989	
30 April	Wild	F	670	3.3	1988	
30 April	Wild	F	620	4.2	1988	
30 April	Wild	M	630	3.2	1989	
30 April	Wild	F	720	3.3	1988	H
1 May	Hatchery	F	670	1.3	**1990**	
1 May	Wild	F	650	4.2	1988	
1 May	Wild	M	680	3.2	1989	
1 May	Wild	F	755	3.3	1988	
1 May	Wild	F	750	3.3	1988	H
1 May	Wild	F	670	3.2	1989	
1 May	Wild	M	670	4.2	1988	
1 May	Wild	F	700	3.2	1989	
1 May	Wild	M	620	3.2	1989	H
2 May	Wild	M	620	3.2	1989	
2 May	Wild	F	720	2.2	1990	
2 May	Wild	M	680	3.2	1989	
2 May	Wild	F	760	3.3	1988	
2 May	Wild	F	715	3.3	1988	
3 May	Hatchery	F	715	1.3	**1990**	
3 May	Hatchery	F	725	1.3	**1990**	
3 May	Hatchery	M	555	1.2	1991	

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Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
3 May	Wild	M	645	3.2	1989	
3 May	Wild	F	840	3.3S1	1987	
3 May	Wild	F	600	3.2	1989	
3 May	Wild	F	720	3.3	1988	F
3 May	Wild	F	660	3.2	1989	
3 May	Wild	F	725	3.3	1988	H
3 May	Wild	F	640	4.2	1988	
4 May	Wild	M	590	2.2	1990	
4 May	Wild	M	750	2.3	1989	
6 May	Hatchery	F	745	1.3	**1990**	
6 May	Wild	F	600	4.2	1988	
6 May	Wild	F	630	3.2	1989	
6 May	Wild	M	630	3.3	1988	
6 May	Wild	M	865	R.3	Unknown	
6 May	Wild	M	860	3.3	1988	
6 May	Wild	----	----	----	Unknown	
6 May	Wild	F	670	3.2	1989	
6 May	Wild	M	690	3.2	1989	
7 May	Hatchery	F	780	1.3	**1990**	H
7 May	Wild	M	770	3.3	1988	H
7 May	Wild	M	745	4.3	1987	
7 May	Wild	F	745	3.3	1988	
7 May	Wild	F	755	3.3	1988	
7 May	Wild	F	610	3.2	1989	
7 May	Wild	F	780	4.3	1987	H
8 May	Wild	M	650	2.2	1990	
8 May	Wild	F	810	3.3	1988	
8 May	Wild	F	600	3.2	1989	
8 May	Wild	F	725	3.3	1988	
9 May	Hatchery	F	740	Unreadable	Unknown	
9 May	Wild	F	760	2.3	1989	
9 May	Wild	F	740	2.3	1989	
9 May	Wild	M	595	2.2	1990	
10 May	Wild	M	620	3.2	1989	
10 May	Wild	F	680	3.2	1989	
10 May	Wild	M	835	3.3	1988	
10 May	Wild	F	700	3.2	1989	
11 May	Hatchery	----	----	----	Unknown	
11 May	Wild	F	640	4.3	1987	
11 May	Wild	M	820	3.3	1988	
11 May	Wild	F	830	3.3S1	1987	
11 May	Wild	F	790	4.3	1987	
11 May	Wild	F	680	3.3	1988	
11 May	Wild	F	780	4.3S1	1986	
11 May	Wild	F	755	3.3	1988	
12 May	Wild	M	780	3.3	1988	
12 May	Wild	F	655	3.2	1989	

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Date	Hatchery / Wild	Sex[a]	FL (mm)	Age	Brood Year	Scars[b]
12 May	Wild	F	750	3.3	1988	
13 May	Wild	M	765	2.3	1989	
14 May	Wild	F	660	3.2	1989	
14 May	Wild	F	630	Unreadable	Unknown	
15 May	Wild	F	575	3.2	1989	
15 May	Wild	M	570	2.2	1990	
15 May	Wild	F	775	3.3	1988	
15 May	Wild	F	670	4.2	1988	
16 May	Hatchery	M	540	1.2	1991	
16 May	Wild	F	760	3.3	1988	
17 May	Wild	M	590	4.2	1988	
18 May	Wild	F	560	3.2	1989	
19 May	Hatchery	F	710	1.2S1	**1990**	
19 May	Wild	F	620	3.2	1989	
19 May	Wild	F	585	3.2	1989	
19 May	Wild	F	595	3.2	1989	
19 May	Wild	F	590	3.2	1989	
19 May	Wild	F	680	3.2	1989	
20 May	Hatchery	F	680	1.3	1990	H
20 May	Wild	F	625	Unreadable	Unknown	
20 May	Wild	F	610	3.2	1989	
20 May	Wild	F	770	3.3	1988	
21 May	Wild	F	710	3.3	1988	
21 May	Wild	F	715	3.3	1988	
21 May	Wild	M	640	3.2	1989	
22 May	Wild	F	600	3.2	1989	
23 May	Wild	M	630	4.3	1987	
23 May	Wild	F	680	3.2	1989	
23 May	Wild	F	775	3.3	1988	
24 May	Wild	F	800	----	Unknown	
24 May	Wild	F	685	----	Unknown	
24 May	Wild	F	780	----	Unknown	
25 May	Wild	F	720	----	Unknown	
25 May	Wild	M	805	----	Unknown	
26 May	Hatchery	F	690	1.3	**1990**	
26 May	Wild	F	810	3.3	1988	
28 May	Wild	F	770	----	Unknown	
28 May	Wild	F	570	----	Unknown	
30 May	Wild	F	615	----	Unknown	
31 May	Wild	F	635	----	Unknown	
4 June	Wild	F	790	----	Unknown	
15 June	Wild	M	640	----	Unknown	
19 June	Wild	F	740	----	Unknown	
29 June	Wild	F	710	----	Unknown	
8 July	Wild	F	640	----	Unknown	

[a] F = female, M = male.

[b] Fish with suspected gillnet marks, as identified in ADF&G (*unpublished*) and by D. Wood, Alaska Department of Fish and Game, Sitka, personal communication. F = fresh, H = healed scar.

Appendix A6.-Date, origin (hatchery or wild stock), sex, fork length, age, and brood year of adult steelhead passed downstream through the Ward Creek weir and steelhead harvested in the creel survey, spring 1994.

Date	Hatchery/Wild	Sex[a]	FL (mm)	Age	Brood Year	Creel[b]	Upstream[c]
20 March	Hatchery	F	735	1.3	**1990**	X	
31 March	Hatchery	F	680	1.3	**1990**		
3 April	Hatchery	M	740	1.3	**1990**		
12 April	Hatchery	M	730	2.2	**1990**		
12 April	Hatchery	M	640	1.3	**1990**		
13 April	Hatchery	F	675	1.3	**1990**		
13 April	Hatchery	F	690	1.3	**1990**		
14 April	Hatchery	M	700	1.3	**1990**	X	
14 April	Hatchery[d]	M	770	1.3	**1990**	X	X
15 April	Hatchery	M	745	1.3	**1990**		
15 April	Hatchery	M	825	1.3	**1990**		
21 April	Hatchery	F	670	1.3	**1990**		
21 April	Hatchery	M	650	1.3	**1990**		
22 April	Hatchery	F	720	1.3	**1990**		
3 May	Hatchery	M	740	1.3	**1990**	X	
3 May	Wild						
7 May	Hatchery	M	650	1.2	1991	X	
8 May	Hatchery	M	755	1.3	**1990**	X	
9 May	Wild						
9 May	Hatchery						X
9 May	Wild						
9 May	Hatchery	M	740	Unreadable	Unknown		
10 May	Hatchery	F	740	2.3S1	1988		
10 May	Wild						
10 May	Hatchery						X
10 May	Wild						X
11 May	Hatchery	M	625	1.2S1	**1990**		
11 May	Wild						
11 May	Hatchery						X
11 May	Wild						
11 May	Hatchery	F	730	1.3	**1990**		
11 May	Hatchery						X
11 May	Wild						X
11 May	Hatchery						X
11 May	Hatchery	F	660	1.3	**1990**		
11 May	Wild						
11 May	Wild						
11 May	Wild						
11 May	Wild						
11 May	Hatchery						X
11 May	Wild						X
11 May	Hatchery	F	620	1.3	**1990**		
11 May	Wild						X

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Date	Hatchery/Wild	Sex[a]	FL (mm)	Age	Brood Year	Creel[b]	Upstream[c]
11 May	Wild						
11 May	Hatchery						X
11 May	Wild						
11 May	Hatchery	F	780	2.3S1	1988		
11 May	Wild						
11 May	Hatchery	F	710	1.3	**1990**		
11 May	Hatchery						X
11 May	Hatchery						X
11 May	Wild						
12 May	Wild						
12 May	Hatchery	F	725	1.3	**1990**		
12 May	Hatchery	F	695	Unreadable	Unknown		
12 May	Wild						
12 May	Wild						
12 May	Hatchery	F	710	1.3	**1990**		
13 May	Hatchery[d]	F	740	1.3	**1990**	X	X
13 May	Hatchery						X
13 May	Wild						
13 May	Hatchery						X
20 May	Wild						X
21 May	Wild						
22 May	Wild	F					
22 May	Wild	F					X
22 May	Wild	M					
22 May	Wild	F					X
23 May	Hatchery	F	700	1.3	**1990**		
23 May	Wild						
23 May	Wild						
23 May	Wild						X
23 May	Wild						X
23 May	Wild						X
23 May	Wild						X
23 May	Wild						
23 May	Hatchery	F	705	Unreadable	Unknown		
23 May	Wild						X
23 May	Hatchery						X
23 May	Wild						
23 May	Hatchery						X
23 May	Wild						
23 May	Hatchery						X
23 May	Hatchery	F	690	1.3	**1990**		
23 May	Wild						X
23 May	Hatchery	M	775	1.3	**1990**		
24 May	Wild						X
24 May	Hatchery	F	665	1.2S1	**1990**		
24 May	Wild						X

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Date	Hatchery/Wild	Sex[a]	FL (mm)	Age	Brood Year	Creel[b]	Upstream[c]
24 May	Wild						X
24 May	Hatchery						X
24 May	Wild						X
24 May	Hatchery	F	685	1.2S1	**1990**		
24 May	Wild						X
24 May	Hatchery						X
24 May	Wild						X
24 May	Hatchery						X
24 May	Wild						X
24 May	Hatchery	F	760	2.3S1	1988		
24 May	Hatchery	F	685	1.3	**1990**		
24 May	Wild						X
24 May	Hatchery						X
24 May	Hatchery						X
24 May	Hatchery						X
24 May	Wild						X
24 May	Wild						X
24 May	Wild						X
24 May	Hatchery	F	710	1.3	**1990**		
24 May	Wild						X
24 May	Hatchery						X
24 May	Wild	M					X
24 May	Wild	F					
24 May	Wild	M					
24 May	Wild	F					X
24 May	Wild	M					
24 May	Wild	F					X
24 May	Wild	F					X
24 May	Wild	F					X
24 May	Wild						X
24 May	Hatchery[c]	F	760	2.3S1	1988		
24 May	Hatchery	M	785	1.3	**1990**		
24 May	Wild						
24 May	Hatchery	F	770	1.3	**1990**		
25 May	Wild	M					
26 May	Wild						X
26 May	Wild						X
26 May	Wild						X
26 May	Wild						
26 May	Wild						
26 May	Wild						X
26 May	Wild						X
27 May	Wild						X
27 May	Wild						X
27 May	Wild						X
28 May	Hatchery						X
28 May	Wild	F					X

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Date	Hatchery/Wild	Sex[a]	FL (mm)	Age	Brood Year	Creel[b]	Upstream[c]
28 May	Wild						X
28 May	Wild						X
28 May	Hatchery						X
28 May	Wild						X
28 May	Hatchery						X
28 May	Wild						
29 May	Wild						X
29 May	Wild						X
29 May	Wild						X
29 May	Wild						X
29 May	Hatchery						X
29 May	Wild						X
29 May	Wild						X
29 May	Wild						X
29 May	Wild						X
29 May	Wild						X
29 May	Wild						X
30 May	Hatchery						X
30 May	Wild	M					
30 May	Wild						X
30 May	Wild						X
30 May	Wild						X
30 May	Wild						X
31 May	Wild						X
31 May	Wild	F					X
31 May	Wild	F					
31 May	Wild						X
1 June	Wild						X
1 June	Wild						X
1 June	Wild						X
1 June	Wild						X
1 June	Wild	M					
1 June	Wild	F					
1 June	Wild	F					X
1 June	Wild	M					
1 June	Wild	F					X
1 June	Wild	F					
4 June	Wild						X
4 June	Wild						X
4 June	Wild						X
7 June	Wild						X
7 June	Wild						
7 June	Wild						X
8 June	Wild						X
11 June	Wild						X
12 June	Wild						X

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Date	Hatchery/Wild	Sex[a]	FL (mm)	Age	Brood Year	Creel[b]	Upstream[c]
12 June	Wild						X
12 June	Wild						X
12 June	Wild						X
12 June	Wild						X
12 June	Wild						X
12 June	Wild						X
12 June	Wild						X
12 June	Wild						X
12 June	Hatchery						X
12 June	Wild						X
12 June	Wild						X
12 June	Wild						X
13 June	Wild						X
13 June	Hatchery	F	780	2.3S1	1988		
13 June	Wild						X
13 June	Wild						X
20 June	Wild						X
20 June	Wild						X
22 June	Wild						X
28 June	Wild						
28 June	Wild						X
28 June	Wild						X
28 June	Hatchery						X
28 June	Wild						X
28 June	Wild						X
29 June	Wild						X
29 June	Wild						X
29 June	Wild						X
29 June	Wild						X
29 June	Hatchery						X
30 June	Hatchery						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild		804				
30 June	Wild		740				X
30 June	Hatchery		625	Unreadable	Unknown		
30 June	Wild		720				X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X

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Date	Hatchery/Wild	Sex[a]	FL (mm)	Age	Brood Year	Creel[b]	Upstream[c]
30 June	Wild						X
30 June	Hatchery						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
30 June	Wild						X
1 July	Wild						
1 July	Wild						
1 July	Wild						
1 July	Wild						
6 July	Hatchery						X
6 July	Hatchery	F	765	1.3	**1990**		
6 July	Wild						X
6 July	Wild						X
6 July	Wild						X
6 July	Hatchery						X
7 July	Wild						X
7 July	Wild						X
7 July	Wild						X
7 July	Hatchery						X
8 July	Wild						
8 July	Wild						X
8 July	Wild						X

[a] F = female, M = male.

[b] Steelhead harvested and sampled in creel survey; all other fish were sampled at the weir.

[c] Steelhead previously passed upstream through the weir.

[d] Mortality recovered upstream of weir.

Appendix A7.- Estimated steelhead harvested in the Ward Creek sport fishery from 1980-1993. Estimates are from the Alaska Statewide Harvest Surveys.

Year	Harvest
1980	-
1981	-
1982	94
1983	153
1984	236
1985	547
1986	458
1987	359
1988	455
1989	130
1990	431
1991	236
1992	171
1993	50

Appendix A8.-Computer data files used in the analysis of this study.

File Name	Description
a0100m_3.dta	Mark sense ASCII file containing creel survey data of steelhead catch and harvest and effort in 1993
a0100m_4.dta	Mark sense ASCII file containing creel survey data of steelhead catch and harvest and effort in 1994